2002 Energy Efficiency Program

Local Nonresidential HVAC Retrofit

California Building Energy Initiative

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Proposal for: California Building Energy Initiative

1. Program Overview

1.1 Program Description and Objectives

Program Specifics:

This proposal seeks electric public goods charge funding for the California Building Energy Initiative (CBEI) program in the Local HVAC Nonresidential Retrofit category ($3.969 million in 2002 and $5.418 million in 2003). The program seeks California Public Utilities Commission (Commission) approval for implementation during calendar years 2002 and 2003. The program targets the commercial HVAC retrofit market and includes building-specific problem identification through data acquisition and analysis, engineering, and financial incentives for building owners and property managers to improve and replace their HVAC equipment. Reductions in lighting energy use will also result from the program, though lighting is not the main focus. Of the 14 market segments identified by the Commission, the California Building Energy Initiative program targets the Large Nonresidential Comprehensive Retrofit, Nonresidential HVAC Equipment Turnover, Nonresidential Motor Turnover, and Nonresidential Renovation and Remodeling segments. This program does not duplicate any of the programs of the IOUs, and is a complement to them.

Program Description:

The CBEI was begun as a Third-Party Initiative in 2001 with funding from Southern California Edison (SCE) and the California Public Utilities Commission. It focuses on improving the energy efficiency of the cooling components of HVAC systems. Portable data acquisition equipment and sophisticated analysis software are used to investigate the operation of HVAC system components; and engineering analysis and computer simulations are used to develop energy efficiency recommendations that are implemented by building owners and managers. These recommendations include equipment replacements and operational changes. Originally conceived as a retrocommissioning program, the majority of the recommendations made during the CBEI Pilot Program and implemented by customers are retrofits to motors, controls, and other components of the HVAC systems. Ten buildings participated in the pilot. The total electrical energy used annually by all ten buildings is 24,640,000 kWh. The total cost of this energy was $3,000,015. The recommendations that were made and actions taken by all the participants are expected to reduce energy consumption by 4,000,000 kWh, or approximately 16%. Operating costs will be reduced by at least $451,000, about 15%. The cost to implement these recommendations for all buildings is estimated to be $485,000, for an average payback of one year. The payback periods for individual recommendations vary from immediate to seven years. The cost to implement the Pilot Program was $300,000.

The projected savings and economic performance (simple payback) of the Pilot Program buildings are in line with the experience and results of other similar retrocommissioning and efficiency improvement efforts, where energy savings ranged from 5-35% with an average around 12-17%. Three documents that discuss the experience and results from these previous projects are identified in Section 6.3 of our proposal. This proposal builds on the lessons learned and success of the CBEI Pilot Program, it continues the program in the service territory of Southern California Edison (SCE), and extends the program activities to the service territories of Pacific Gas & Electric (PG&E) and San Diego Gas & Electric (SDG&E). In keeping with the

requirements of crosscutting local programs, it is not necessary for the CBEI to be conducted in all the IOU service territories. Information is provided in this proposal for implementation in all three IOU territories, and it is left up to the Commission to determine whether to fund the CBEI in one, two, or three of them.

Since the CBEI is already operating, less time will be required to expand the program to a larger customer base than will be required for a totally new program. More customers wanted to participate in the Pilot Program than funding would allow. They will likely be the first participants in an expanded program. In addition, the CBEI program will leverage its relationships with customers who have buildings in two or more of the IOU service territories. AEC's Web site with CBEI Pilot Program documents can be viewed at http://www.archenergy.com/cx/cbei.htm.

Program Objectives:
The California Building Energy Initiative will eliminate the unnecessary consumption of energy in existing commercial buildings and produce long-term energy savings. The target of this work is HVAC system cooling components. However, reductions in wasteful lighting energy use will also be achieved. Two additional objectives are as follows: 1) to train customer's building operation and maintenance personnel to identify wasteful energy use themselves, and 2) to ensure that the savings created in this program persist over their expected lifetimes. The project team will conduct training sessions during which participants will learn to use data logging equipment to investigate equipment performance in their buildings after the CBEI activities are complete. Each participant will be given two data loggers, temperature sensors, and current transducers. In addition, a permanent data gathering system will be installed in each building to continuously monitor critical parameters of systems that are improved under this program. For a period of three years, AEC and building operators will be notified when critical values are exceeded. The building operators will be responsible for taking corrective actions. These systems will also be used to implement the evaluation, measurement, and verification plans.

The California Building Energy Initiative will deliver long-term energy savings with Effective Useful Lives (EULs) between 10 and 15 years, meeting the Commission's minimum target of three years for long-term energy savings. Broader, longer-term energy-saving impacts of CBEI also result from the training activities offered during program delivery, and the performance monitoring equipment they will be given. Skills learned by the building O&M staff members will be transferred to others in the normal course of work. The concern for energy efficiency will be elevated for owners, managers, and operators of commercial buildings.

Inclusive of both the energy savings components as well as training elements, the program provides highly cost-effective savings. Implementation during 2002 and 2003 is forecasted to produce 77,460,000 kWh of annual energy savings and total peak demand reductions of 8.59 MW.

Architectural Energy Corporation (AEC) will deliver the program along with its subcontractor organizations, CTG Energetics, Inc. (CTG), RLW Analytics, Inc. (RLW), Eley Associates (Eley), Portland Energy Conservation, Inc. (PECI), and Eskinder Berhanu & Associates (EBA). AEC has experience working with all the subcontractor organizations. CTG and RLW are

subcontractors to AEC to deliver the CBEI Pilot Program in SCE's service territory. AEC is currently a subcontractor to PECI on their pilot retrocommissioning program for SDG&E. AEC is working with Eley and EBA on Public Interest Energy Research (PIER) projects funded by the California Energy Commission.

1.2 Market Barriers

The pilot phase of the California Building Energy Initiative identified and addressed a number of market barriers.

Lack of awareness and credible information about energy waste in HVAC systems and the benefits of energy efficiency. The CBEI is designed to overcome market barriers such as a lack of awareness and credible information about the magnitude of energy waste in existing HVAC systems, what actions can be taken to improve energy efficiency, and the amount of energy and money that they can saved by implementing them. Most customers do not understand that comfort and energy efficiency are not synonymous. The prevailing attitude among customers is that if they are comfortable, then everything must be okay. They do not realize that energy inefficient systems can provide comfort. Field investigations, data analysis, and cost/benefit calculations will be provided to customers as part of the CBEI to over come this barrier. This increases their understanding of the merits of energy efficiency and helps to implement the governor's message that urges customers to conserve.

Confidence that energy efficiency recommendations are valid. A key component of the CBEI is time-series data documenting actual building performance. AEC coined and servicemarked the slogan, "The difference between 'I think' and 'I know'"[sm] to describe the additional understanding of building performance and the confidence that comes from collecting and analyzing building performance data. The essence of the CBEI is to develop the infrastructure and capabilities for measurement-based energy efficiency programs to be delivered in the service territories of each of the IOUs. Data acquisition hardware, data analysis software, and training will be made available at no cost to HVAC maintenance professionals through this program. In addition, documentation and case studies will be developed and displayed on AEC's Web site and widely distributed through building owner associations and other trade organizations. These will allow operators of these buildings to reassess their performance in the future, and will allow non-participants to read about the actions taken in buildings similar to their own. The CBEI will promote an understanding of the investment potential of energy efficiency. An example of one of the CBEI Pilot Project case studies can be viewed via the Internet at http://www.archenergy.com/cx/cbei_jnjcs.htm.

Confidence that customers' best interests are being served. Some customers have developed distrust for organizations delivering energy efficiency programs. This occurs most often because of their direct experience dealing with an energy service company (ESCo), the experience of others they have heard about, or contact with ESCo sales personnel. The CBEI does not operate like an energy service company. The CBEI is designed to serve the best interests of the customer. The customer does not have to pay for the services of the CBEI and is not required to reimburse the project for expenses, in the event they do not implement recommendations. Therefore, customers feel that an objective third party is looking out for their (the customer's) best interests.

Landlord/tenant issues in leased space. In the past, landlords have seen no benefits to improving the energy efficiency of equipment, because under triple-net leases the tenants pay the energy bills. Tenants have limited term leases, and are subject to a high rate of turnover, making them uncertain that they will be in a space long enough to recoup their investments in energy efficiency. Increasing energy prices are changing landlords' and tenants' perspective on energy costs. Progressive landlords understand that tenants are aware of energy costs and are attracted to buildings with low operating costs. Tenants are including energy costs in their criteria for selecting leased space. The CBEI is a cost-effective program to create a win-win situation for both landlords and tenants.

Disconnect between operating and capital budgets. Often customers have very tight operating budgets and no margin to engage engineering services to investigate energy savings opportunities. The CBEI provides this service at no cost to the customer. It also accurately calculates the benefits to the customer for improving energy efficiency so that decision makers can precisely determine the number of operating dollars that can be devoted to efficiency improvements and still stay within budget at the end of the year. The results also provide documentation of the investment potential of budgetary allocations in the energy efficiency arena, so that actions with longer payback periods can be properly evaluated and included in annual property management budgets.

1.3 Innovation

Architectural Energy Corporation is a pioneer in the development of portable data acquisition equipment and software for conducting fault detection and diagnostics on commercial HVAC equipment. AEC's MicroDataLogger® data acquisition equipment and ENFORMA® diagnostic software were used in the Pilot Program and will be used again in the proposed expanded CBEI program. Both SCE and PG&E own and use the MicroDataLogger (MDL) equipment in their research and efficiency programs. PG&E has MDL equipment in its lending library and was also a sponsor of the development of the ENFORMA software. These tools are also being used in the pilot retrocommissioning program sponsored by SDG&E for which PECI is the prime contractor and AEC is a subcontractor.

This program will build on the success of the California Building Energy Initiative Pilot Program and expand the concept to the service territories of PG&E and SDG&E. The lessons learned in the pilot will be applied to the full-scale implementation of the program.

2. Program Process

2.1 Program Delivery/Participant Process

The program enrollment process for CBEI participants is as follows:

- Individual participants will be identified through breakfast seminars and presentations at professional organization meetings, targeted mailings to specific market segments and networking for leads. Participants will be contacted directly with an explanation of the program opportunity, information on the benefits and an offer of assistance in completing the program process. AEC's Web site (www.archenergy.com) contains a

complete description of the California Building Energy Initiative, documents to complete to participate, and case studies of completed projects.

- Potential participants express their interest in participating in the program, discuss the details of the program with an AEC representative, and submit an application.
- AEC reviews and screens the applications, and selects participants based on the potential for cost-effectively saving energy. Screen criteria include the types of systems in the building (such as electric reheat), the energy utilization index (EUI, kWh/sq. ft.), and location. (Preference will be given to rural locations to meet the goals set forth in this proposal for hard-to-reach customers.)
- AEC develops a Memorandum of Understanding for the customer to sign. The MOU outlines the roles and responsibilities of the CBEI project team and the customer, including agreed-upon project details, incentive amounts, and terms and conditions.
- Participants sign and date the agreement and return it to AEC. Signing the MOU acknowledges that they have read and agree to all the terms and conditions. They agree to provide CBEI program team personnel access to the building and assistance installing instrumentation. They also agree that they will obtain estimates of the costs to make improvements, that they will send operations staff to a training session, and that they will provide billing statements for electricity and gas for at least 12 months.
- Program team conducts audits, short-term monitoring, and engineering and cost analysis.
- Program team members and participants review the recommendations report and agree on the improvements to make and an incentive payment.
- The customer implements the improvements.
- After the improvements are made, the participant notifies AEC.
- The CBEI program team verifies that the improvements are made properly, and installs the continuous monitoring system.
- The participant's operations staff members receive training and are given portable testing equipment to investigate the performance of other buildings under their control.
- If, after inspection, the improvements differ from those previously agreed upon, a recalculation of the incentive amount will be performed by AEC.
- Incentives are paid after all other program requirements are satisfied. An incentive check is issued to the participant.
- Equipment is installed to continuously monitor the performance of improved components and systems.
- Utility bills and performance data from the continuous monitoring equipment is regularly reviewed by AEC staff to ensure persistence of savings and as part of the M&V process.

2.2 Marketing and Outreach

AEC and PECI will develop a marketing strategy to ensure strong owner participation. Program marketing will include activities to 'get the word out' to target audiences, followed by direct contact with individuals receiving program information. Marketing strategies will be developed to reach rural customers. Strategies will include hosting Owner Breakfasts to promote the program benefits and publicizing the program through BOMA meetings, Chamber of Commerce meetings, and other professional organizations. Further strategies will target potential participant

groups with mailings and direct contact. See Section 2.4 for a list of organizations with which the project team will work.

Specific market sectors will also be sent program materials through separate mailings. AEC's subcontractor, PECI, will further research, and segment these sectors and methodically contact individual businesses to identify those who may be the best program candidates. These businesses will be contacted directly with an explanation of the CBEI program opportunity, information on the benefits, and an offer to assist in completing the program application process. Additional site information, that would be useful for both screening and field surveys, may be gathered at this time. If the site has potential, PECI will promote the program opportunity and confirm decision-maker interest in participating. PECI will also identify potential participants through contacts in professional and business organizations, trade groups, building services providers and utilities.

To assure a uniform approach with clear program messaging, AEC and PECI will produce a standard sales presentation for members of the project team to use as they identify potential participants and contact them directly. This presentation, and associated program description/marketing materials, will explain the program approach, the energy savings potential, available financial assistance, and include brief case study information. Collateral materials will be developed that also inform customers of the benefits of the CBEI. AEC will produce a brochure for owners and a series of fact sheets to build awareness of the benefits of the CBEI and promote participation in the program.

2.3 Procedures for Equipment Purchase or Installation

Architectural Energy Corporation has tested and/or commissioned more than 300 buildings. We have found cooling system problems that had gone undetected and uncorrected by the maintenance and operations staff. These "silent killers" cause significant excess energy consumption and they can often be eliminated at low cost. During the CBEI Pilot Program, we were able to reduced electrical energy consumption by an average of 12% through improvements with an average payback of one year. The CBEI program will firmly establish the infrastructure to identify and eliminate silent killers in the cooling systems of commercial buildings in California now and on into the future.

The following are observations about problems found in the HVAC system components that are the targets of the CBEI:

Chillers – Chillers are often the single biggest equipment loads in commercial and institutional buildings and almost always set the peak summer demands. The key concern for most building operators is whether or not the chiller is meeting a designated chilled water setpoint. Operators tend to be more concerned with maintaining comfort than they are about the energy efficient operation of the equipment. Consequently, three operating scenarios commonly occur that result in excess energy use. These are usually easy to remedy by reprogramming the building automation system.

- *Chilled water setpoint too low*. Operators often lower the chilled water setpoint during periods with peak cooling loads. However, they forget to reset it and it remains at the low

value continuously or until they receive complaints of discomfort. Raising the setpoint by a few degrees during periods of smaller loads can save substantial amounts of energy. Often automatic chilled water reset controls have been overridden or were never employed during the initial start-up of the chiller system.

- *Improper staging*. Most electric chillers are more efficient operating at higher loads. Many buildings will have more than one chiller. Quite often two chillers will operate at low loads, when one has sufficient capacity to meet the load. For more energy efficient operation, a single smaller chiller should be used to meet lower loads, and multiple chillers used to meet the higher ones.

- *Chillers energized when unnecessary*. Chillers are often operated when outdoor air can meet cooling loads with airside economizers. This results in the chiller being operated at low loads when they are not needed. Carefully determining the "balance point" of the building and then setting an appropriate ambient lockout can reduce the number of hours a chiller is operated, hence reducing kilowatt hours consumed, and potentially reducing peak demands in months with moderate weather.

Collecting and analyzing chiller performance data is the only way to determine if their dynamic performance is optimal. Potential chiller problems that are investigated using time series data include: proper staging, proper temperature resets, meeting load or drifting, maintaining proper temperature differentials, and normal or short cycling. Efficiency (kW per ton) can also be calculated.

The improvements made to the chillers in buildings that participated in the CBEI Pilot Program are listed below. Chiller improvements in the CBEI program sponsored by the CPUC are expected to be similar.

- Reset chilled water supply temperature.
- Reset condenser water supply temperature.
- Integrated chillers with direct digital control (DDC) systems.
- Installed variable speed drives (VSD) on chilled water pumps.
- Staged chillers to prevent two chillers from operating, when on chiller could meet the load.

Cooling Towers – Cooling towers are a key component of most large cooling systems and their performance and operation can have a large impact on the efficiency of the chillers and the total energy use and peak demands of the entire cooling system. Following are three common operational characteristics of cooling towers that can cause excess energy consumption:

- *High condenser water temperatures.* Similar to the condition for chilled water temperature discussed above for chillers, the condenser water temperature is often set too high. Electric chillers run more efficiently at low condenser temperatures.

- *Excessive cycling of fans*. This condition is most common on large towers with single, constant speed fans. Excessive cycling is common at low loads and causes wear on motors and drive systems (belts, pulleys, etc). This condition can be reduced by slightly increasing

the control deadband of the condenser water setpoint or installing two-speed motors or variable speed drives.

- *Poor maintenance.* This reduces heat transfer efficiencies and requires excess fan energy to reject heat from a tower. It is often a result of poor water treatment.

Time series performance data collected on cooling towers is used to investigate: approach to wet bulb temperatures, condenser water temperature differential, condenser water reset, and fan cycling and staging. Static tests are not sufficient to investigate these parameters over a range of operating conditions.

The improvements made to the cooling towers in buildings that participated in the CBEI Pilot Program are listed below. Cooling tower improvements in the CBEI program sponsored by the CPUC are expected to be similar.

- Improved control of cooling tower fans to eliminate cycling.
- Installed variable speed drives (VSD) on cooling tower fans.
- Added variable frequency controls (VFC) to cooling tower fans.
- Added wet bulb reset to cooling towers.

Economizers – Economizers are designed to reduce the need for mechanical cooling when outside air temperatures and humidity (in the case of enthalpy controlled economizers) are low enough to provide "free cooling." Only a small percentage of the economizers we have studied actually work properly. Two of the common faults are outside air dampers locked in either the minimum air setting or locked in the maximum air setting. When the dampers are in the minimum air setting, the "free cooling" the system is supposed to provide is never realized. Mechanical cooling is necessary at times when free cooling should be available. This increases the cooling requirements in morning and evening hours, as well as during the cooler swing months. When the dampers are in the maximum air position, the free cooling is realized, but the peak loads are increased. These excess loads are particularly prevalent during the hottest hours on summer months. Restoring economizers to proper operation reduces both energy consumption and peak summer demand. Only time series performance data will reveal these problems over a range of operating conditions. It will also clearly show the interaction between the operation of system components, such as the economizer and chiller or compressor.

The improvements made to the economizers and air distribution fans in buildings that participated in the CBEI Pilot Program are listed below. Economizer and fan improvements in the CBEI program sponsored by the CPUC are expected to be similar.

- Repaired broken economizers.
- Reset fan static pressure.
- Installed VFDs on supply and return fans.

Simultaneous Heating and Cooling – Oftentimes, heating and cooling are supplied to spaces at the same time. This can happen if a space is cooled using one system and heated using an independent system. Common independent heating systems are electric heaters at the outlet of

the ducts (terminal reheat) and electric baseboard heaters. The heating and cooling systems can run simultaneously without causing perceptible comfort problems, so these conditions are rarely reported to maintenance personnel. Eliminating simultaneous heating and cooling is often a matter of coordinating setpoints, locking out the heating during summer months, or changes to control logic. All of these are inexpensive. Whenever simultaneous heating and cooling exist, both excess energy consumption and increased peak summer demand are caused.

The improvements made to the buildings that participated in the CBEI Pilot Program to prevent simultaneous heating and cooling are listed below. Improvements in the CBEI program sponsored by the CPUC are expected to be similar.

- Added control of electric resistance duct heaters to the energy management system (EMS).
- Reset hot deck temperatures.
- Shut down boilers and pumps during the summer months.
- Changed the schedule of the hot water pump and boiler.

Controls – Improving and changing the controls to a building can result in significant energy savings. Direct digital controls have the potential to provide better control than pneumatic controls. Scheduling equipment plays an important role in the overall energy used by a building.

The improvements made to the controls in buildings that participated in the CBEI Pilot Program are listed below. Improvements to controls in the CBEI program sponsored by the CPUC are expected to be similar.

- Converted pneumatic controls to DDC controls.
- Reduced the operating schedule for the HVAC and lighting systems.
- Reduced the schedule of packaged rooftop units.

2.4 Synergies and Coordination

During the Pilot Phase of the CBEI, AEC established effective working relationships with many organizations involved in building ownership or management. For the expanded CBEI, will build upon these relationships and establish new ones to recruit customers to participate in the program. These organizations include:

The California Commissioning Collaborative

The California Commissioning Collaborative is an ad hoc group of government, utility, and building services professionals who are committed to developing and promoting viable building commissioning practices in California. The CCC seeks to facilitate the development of cost effective programs, tools, techniques and service delivery infrastructure that enables the implementation of the building commissioning process throughout California. Members of the CBEI team are active in the California Commissioning Collaborative and will use its resources to publicize the program and recruit participants.

California Energy Commission

Architectural Energy Corporation is a contractor to the California Energy Commission (CEC) operating one of its three programmatic research programs. AEC is also a participant in two

other projects sponsored by the CEC. We will brief project managers at the CEC about the CBEI program, and invite them to refer inquiries from customers wanting to improve the efficiency of existing facilities to CBEI program team members.

The Collaborative for High Performance Schools (CHPS)

This collaborative aims to increase the energy efficiency of public schools in California by marketing information, service, and existing incentive programs directly at school districts and designers. The goal of CHPS is to facilitate the design of high performance schools: environments that are not only energy efficient, but also healthy, comfortable, well lit, and contain the amenities needed for a quality education. AEC will work with Eley Associates, the primary contractor for the development of CHPS, to identify opportunities for the CBEI.

Association of Facility Energy Managers (APEM)

Members of APEM are specifically responsible for operating energy consuming equipment in buildings. Membership includes building operators, engineers, controls contractors, and equipment suppliers. Contacts with APEM members were useful during the CBEI Pilot Program. We will contact the program chairpersons of the APEM chapters located in the areas where the CBEI will be conducted. We will ask to make presentations about the operations and benefits of the CBEI at chapter meetings.

Building Owners and Managers Association (BOMA)

Architectural Energy Corporation coordinated with BOMA during the Pilot Project. Many of the potential participants for the CBEI program sponsored by the CPUC are members of BOMA. We will contact the program chairpersons of the BOMA chapters located in the areas where the CBEI will be conducted. We will ask to make presentations about the operations and benefits of the CBEI at chapter meetings.

American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)

Engineers who are members of ASHRAE are another resource for participants in the CBEI. We will contact the program chairpersons of the ASHRAE chapters located in the areas where the CBEI will be conducted. We will ask to make presentations about the operations and benefits of the CBEI at chapter meetings.

Chambers of Commerce, Kiwanis Clubs, and Rotary Clubs

One of the objectives of the CBEI is to reach customers in rural communities. Owners of large buildings in these communities are oftentimes members of the local Chamber of Commerce, Kiwanis Club, or Rotary Club. AEC will contact these organizations in rural areas and ask to speak at breakfast and luncheon meetings to talk about the CBEI, its process, the benefits, and to seek participants.

3. Customer Eligibility

3.1 Customer Segments

The California Building Energy Initiative will be available to all commercial customers who pay electric and gas public goods charges as provided under California Code and regulated by the California Public Utilities Commission within the service territories of SCE, PG&E, SDG&E, or

as selected by the Commission. Consistent with crosscutting local program submission requirements, it is not necessary for the CBEI to be conducted in all the IOU service territories. It can be conducted in one, two, or three service territories, as determined by the Commission.

Special program outreach will be made to groups and markets defined as under-served and hard-to-reach in the Commission's Energy Efficiency Policy Manual with a specific emphasis on rural customers.

3.2 Customer sizes targeted

Buildings that participated in the Pilot Program ranged in size from 60,000 to 470,000 square feet. Annual energy consumption ranged from 826,000 to 6,000,000 kWh per year. Annual peak demand ranged from 375 to 1,930 kW. The full-scale implementation of the CBEI will target buildings with annual energy consumption greater than 800,000 kWh and annual peak demand greater than 350 kW. There are no upper limits on building size, annual energy consumption, or demand.

3.3 Description of geographic area and utility service territory

The majority of the buildings targeted by the CBEI are found in the large urban areas of San Diego, Los Angeles, San Francisco, Oakland, and San Jose. The CBEI will seek to find 10 to 15% of its buildings in rural areas in each service territory.

3.4 Other customer characteristics

The immediate targets for the CBEI are buildings managed by a large property management firm, buildings on small college campuses, buildings that are owner-occupied, and buildings in large worship centers. We have chosen these audiences to create an end user "pull" for these services, as opposed to focusing on HVAC contractors, which creates a service provider "push" program. Additionally, the CBEI concentrates on improving the energy efficiency of HVAC system components that contribute to peak summer demand. These components are chillers, cooling towers, economizers, and heating simultaneous with cooling. These equipment components were selected so that we can include both built-up systems and packaged systems in the program. However, as we work in these buildings, we will also identify other energy saving opportunities that will benefit the customer, such as improved lighting control or lighting retrofits.

Desirable characteristics we look for are buildings that:

- Have full DDC control.
- Have an in-house operations staff.
- Have high electricity consumption.
- Have mechanical equipment in relatively good condition.

3.5 Equity Considerations

While the hard-to-reach market contributes funds to support program activities, they may find it difficult to participate in mainstream energy efficiency programs due to barriers such as geographic location, energy efficiency knowledge, and lease disincentives. The structure and proven methods of the CBEI place it in an ideal position to deliver programs to customers in rural locations.

To equitably serve customers in rural areas, the CBEI program will offer services, training, and data logging equipment to customers. It is designed to:

- Be simple to use;
- Address small colleges and large churches;
- Require less capital investment;
- Provide tools and incentives applicable to specific geographic areas; and
- Provide training opportunities at multiple, strategically located facilities.

4. Cost Effectiveness Calculations

4.1 Cost Effectiveness Summary

The 2002 cost-effectiveness calculations comply with all of the Commission-adopted policies applicable to the 2002 programs. The Total Resource Cost (TRC) and Participant Test ratios for each year and each IOU service territory for this program, calculated pursuant to the Commission's requirements, are shown in the table below.

Utility	Year	Total Resource Cost (TRC)	Participant Test
PG&E	2002	2.66	5.52
SCE	2002	2.66	5.52
SDG&E	2002	2.67	5.52
PG&E	2003	2.60	5.52
SCE	2003	2.61	5.52
SDG&E	2003	2.61	5.52

4.2 Data Sources and Assumptions

The data sources and assumptions are shown in Appendix A – Cost Effectiveness Workpapers.

5. Program Performance Goals

5.1 Energy and Peak Demand Savings Targets

To encourage superior program delivery for all non-information programs, the Commission's Energy Efficiency Policy Manual requires 15% of all program payments to be paid contingent upon achievement of performance goals developed as part of the Commission-approved program design. The following tables provide the proposed energy savings and demand reduction targets for this non-information program in each IOU service territory during each of the two program years. These tables will be updated during the course of the program with verified savings.

Table 5.1: PG&E Territory
Energy Savings And Demand Reduction Targets
California Building Energy Initiative -2002

	Projected Savings	Verified Savings	% of Goal
Energy (kWh):	**15,561,000**		
Demand (kW):	**1,725**		
Average % of Goal			
Program Total Budget:	**$1,869,000**		
Potential Final Payment Amount (15%):	**$280,350**		
Actual Payment Made (85% of Potential):			

Table 5.2: PG&E Territory
Energy Savings And Demand Reduction Targets
California Building Energy Initiative -2003

	Projected Savings	Verified Savings	% of Goal
Energy (kWh):	**20,748,000**		
Demand (kW):	**2,300**		
Average % of Goal			
Program Total Budget:	**$ 2,541,000**		
Potential Final Payment Amount (15%):	**$381,150**		
Actual Payment Made (85% of Potential):			

Table 5.3: SCE Territory
Energy Savings And Demand Reduction Targets
California Building Energy Initiative -2002

	Projected Savings	Verified Savings	% of Goal
Energy (kWh):	**12,448,800**		
Demand (kW):	**1,380**		
Average % of Goal			
Program Total Budget:	**$ 1,496,250**		
Potential Final Payment Amount (15%):	**$224,437**		
Actual Payment Made (85% of Potential):			

Table 5.4: SCE Territory Energy Savings And Demand Reduction Targets **California Building Energy Initiative -2003**			
	Projected Savings	Verified Savings	% of Goal
Energy (kWh):	**16,598,400**		
Demand (kW):	**1,840**		
Average % of Goal			
Program Total Budget:	**$ 2,047,500**		
Potential Final Payment Amount (15%):	**$307,125**		
Actual Payment Made (85% of Potential):			

Table 5.5: SDG&E Territory Energy Savings And Demand Reduction Targets **California Building Energy Initiative -2002**			
	Projected Savings	Verified Savings	% of Goal
Energy (kWh):	**5,187,000**		
Demand (kW):	**575**		
Average % of Goal			
Program Total Budget:	**$ 603,750**		
Potential Final Payment Amount (15%):	**$90,562**		
Actual Payment Made (85% of Potential):			

Table 5.6: SDG&E Territory Energy Savings And Demand Reduction Targets **California Building Energy Initiative -2003**			
	Projected Savings	Verified Savings	% of Goal
Energy (kWh):	**6,916,000**		
Demand (kW):	**770**		
Average % of Goal			
Program Total Budget:	**$ 829,500**		
Potential Final Payment Amount (15%):	**$124,425**		
Actual Payment Made (85% of Potential):			

The achievement towards the energy savings and demand reduction targets shown in Tables 5.1 through 5.6 will be calculated using a simple average ("Average % of Goal") of verified energy and demand savings. The "Average % of Goal" result is multiplied by the "Potential Final Payment Amount" to arrive at the actual payment. The verified energy savings for this program

are based on ex ante energy savings estimates. See Section 6 for more discussion on the verification of this program.

6. Evaluation, Measurement and Verification Plans

6.1 General Approach to Evaluating Program Success

Architectural Energy Corporation and other members of the CBEI project team have conducted many measurement and verification (M&V) and process evaluations for the IOUs in California and for other utility companies around the country. We are familiar with the methods and protocols for implementing these activities. This evaluation, measurement and verification (EM&V) plan for the California Building Energy Initiative meets the EM&V objectives of the Commission outlined in the Energy Efficiency Policy Manual and adheres to the guidelines in the International Performance Measurement and Verification Protocol (IPMVP).

The EM&V for the California Building Energy Initiative program is based on established methods for evaluating commercial retrofit and commissioning program success. The energy efficiency improvements that will be made to each building participating in the CBEI will be determined during the data analysis and engineering phases of each project. This differs from other types of programs, such as lighting or motor retrofits, where the replacement energy efficient technologies are known at the outset, and the M&V methodology does not change from project to project. The general approach to measurement and verification for the CBEI is to use data loggers that are part of the diagnostic process to take measurements at each site before and after improvements are made, then apply Option B or Option D from the IPMVP to calculate energy and demand savings. Details of this tailored approach are explained in the section below. AEC will report energy and demand savings to the sponsoring utility (or utilities) and to the Commission on a periodic basis.

Each of the IOUs have conducted Commercial End-Use Studies (CEUS). These studies include market characteristics for the building stock in their service territory, sizes and types of buildings, construction characteristics, types of HVAC systems, energy consumption, and other information. The CEUS databases along with other relevant resources will be used to establish up-front market assessment and baseline analysis, identify key market segments for targeting program delivery, and to assess the continuing need for the program.

The EM&V plan also includes a process evaluation plan to assess program awareness, effectiveness of program policies and procedures, customer satisfaction with the program, benefits to participants, barriers to program participation, and barriers to implementing energy efficiency recommendations. Process evaluation will be conducted toward the end of the first year of the program so that improvements can be made during the second year.

6.2 Approach to Measuring and Verifying Energy and Peak Demand Savings

Key elements of the California Building Energy Initiative for identifying energy efficiency opportunities, ensuring the persistence of savings, and conducting M&V include portable data loggers used to collect pre-improvement performance data and permanent data acquisition systems used to collect long-term post-improvement performance data. The CBEI program team will install portable data loggers at each building, during the engineering phase, according to

measurement plans automatically developed by the ENFORMA software. These loggers will be used to collect short-term performance data. These data sets will be sufficient to establish pre-improvement performance used for baseline performance definition. M&V plans will be developed to collect post-improvement data as close to the source of savings as possible. Customized measurement plans will be developed for the post-improvement data collection to support continuous commissioning and M&V. Data from the permanent systems will be sent to a central server via telephone, DSL, cellular modem, or LAN connections. Near real-time analysis will be performed on data from all sites.

The protocols of the IPMVP will be applied to calculate energy and demand savings for all participating sites. When it is easy to isolate an ECM and interactive effects are minimal, Option B will be applied. When isolation is not as easy to accomplish or interactive effects need to be evaluated to accurately assess savings, Option D will be applied. Simulations will be performed using the DOE2.1E energy analysis software, whenever Option D is used. A key element for applying Option D will be calibrating the computer models with measured data for schedules, setpoints, and component performance; and the further calibration to match long-term utility energy consumption. We will use the Survey-IT and Model-IT systems to develop cost-effective models to implement Option D.

Free-ridership and spillover effects will be evaluated using customer interviews combined with engineering analysis. AEC has successfully applied this methodology in several areas, including the Building Efficiency Assessment project which is currently evaluating the statewide Savings By Design program.

The key objectives of the M&V activities are to:

- Establish baselines for each participant site.
- Calculate demand and energy savings for each participant site.
- Develop on-going gross whole-building energy and demand impact estimates for the California Building Energy Initiative program.
- Develop on-going impact estimates of both incented and non-incented measure categories.
- Develop on-going estimates of both free-ridership and spillover at the measure and end-use levels.

6.3 Program Evaluation

Program evaluation is an important element of the California Building Energy Initiative because it:

- Improves and focuses the marketing activities.
- Improves the program delivery process, which improves the cost-effectiveness.
- Determines the continuing need for the program.

Market Assessment and Baseline Analysis: The Commercial End-Use Studies (CEUS) conducted by each of the IOUs are the major sources of data about the existing commercial building stock, types and sizes of buildings, HVAC system types, and energy consumption. AEC has worked with these data on previous projects for the utilities. AEC will ask the Commission for copies of the CEUS databases to use in the market assessment activities. The

CEUS data will be used to help develop baseline market characteristics, refine target customers for the program, and contain important data needed to calculate statewide estimates of savings potential. Other important inputs to this process, not addressed by the CEUS, include the prevalence of problems creating wasted energy, the impact of cost-effectively fixing these problems, the availability of infrastructure to fix problems, and the persistence of savings. Existing research and AEC's and PECI's experiences with similar programs will be used to develop these estimates.

The baselines of energy performance and estimates of savings potential used to develop the CBEI program were derived from four sources. The primary source is the data developed during the CBEI Pilot Program. We believe that these data are a reliable indicator of the potential for success. The other three sources of data are reports that were researched and written by our subcontractor, PECI. These are independent sources of savings estimates that compare very favorably with the CBEI Pilot Program estimates. They are:

1. *California Commissioning Market Characterization Study,* Pacific Gas & Electric, November 2000.
2. *National Strategy for Building Commissioning*, U.S. Department of Energy, 1998.
3. *A Practical Guide for Commissioning Existing Buildings,* Oak Ridge National Laboratory, May 1999.

Additional data collected during this process will be used to improve program design and market assessment.

Process Evaluation: An annual process evaluation of California Building Energy Initiative will be conducted to assess the effectiveness of the CBEI delivery mechanism. Surveys will be conducted involving participants and non-participants. The surveys will gauge program awareness, perceived benefits to participating, barriers to participating, the effectiveness of training, and the usefulness of data logging equipment left with each participant.

The key objectives of the process evaluation study are to:

- Provide an on-going process evaluation of the CBEI program to improve delivery efficiency.
- Determine the effectiveness of the program at meeting its goals of reaching under-served markets.
- Determine the success of the program at persisting energy savings.
- Determine the energy and non-energy benefits derived by program participants.
- Determine awareness of CBEI by potential participants, including building owners, managers, and operators.
- Determine barriers to participation in the CBEI.
- Assess overall participant satisfaction with the program.
- Identify structural changes to streamline program design and procedures.
- Evaluate the effectiveness of training and data loggers left with participants to achieve savings in non-participating buildings.
- Assess the need of any additional training of site personnel or service contractors to maximize the persistence of savings provided by the program.

The results from this study will be used to refine CBEI program design and to assess whether there is a continuing need for the CBEI program.

7. Budget

7.1 Budget

This proposal seeks electric Public Goods Charge (PGC) funding for the California Building Energy Initiative program in the Local Nonresidential HVAC Retrofit category for 2002 ($3.969 million) and 2003 ($5.418 million). In the PG&E service territory, we seek $1.869 million in 2002 and $2.541 million in 2003. In the SCE service territory, we seek $1.496 million in 2002 and $2.047 million in 2003. In the SDG&E service territory, we seek $0.604 million in 2002 and $0.829 million in 2003. These costs are inclusive of the 5% administration fee paid to the contracting IOU. The program budget details for each utility service territory in each year are shown in Appendix B – Program Cost Proposal.

8. Qualifications

Architectural Energy Corporation is the primary implementer of the California Building Energy Initiative. AEC has experience conducting large programs in California, other parts of the United States, and other parts of the world. References are provided for AEC at the end of the next section. These are individuals who can attest to the expert manner in which we conduct projects and can comment on our technical and management capabilities. AEC contracted portions of the CBEI Pilot Program to CTG Analytics, Inc., located in Irvine, CA, and to RLW Analytics, Inc., located in Sonoma, CA. AEC will continue working with these two subcontractors, and will add three organizations to its list of subcontractors. These are Eley Associates (Eley) of San Francisco, CA, Eskinder Berhanu & Associates (EBA) of San Diego, CA, and Portland Energy Conservation Inc. (PECI) of Portland, OR. CTG, RLW, Eley, and EBA will all participate in the field engineering, data acquisition and analysis, and reporting activities. PECI will participate in the marketing and customer recruitment activities. Members of the program team have offices throughout the geographic regions targeted for the CBEI. In addition, AEC will station its own personnel in San Francisco, Los Angeles, and San Diego to coordinate and participate in the program activities. Qualifications and references for the subcontractors are presented in Section 8.2.

8.1 Qualifications Of Primary Implementer - Architectural Energy Corporation (www.archenergy.com)

8.1.1 Overview of AEC

Architectural Energy Corporation (AEC) is a leading business-to-business energy engineering firm. For the last 20 years, AEC has helped its clients to achieve and maintain peak building performance over the life of their buildings. This mission is accomplished through the application of a comprehensive and innovative suite of professional services and products – design analysis and sustainable design assistance; commissioning and diagnostic testing; utility and energy service company engineering services; energy information systems, services and data acquisition equipment; Internet services; hardware and software product development; performance evaluation; and market transformation services.

Founded in 1982 by Donald J. Frey, P.E. and Michael J. Holtz, AIA, AEC maintains an interdisciplinary staff of 40 professionals, including mechanical, electrical, and architectural engineers; architects; computer scientists; mathematicians; physicists; technicians; and research support staff to undertake complex and diverse projects related to energy, buildings and the environment. AEC's main office is in Boulder, Colorado. We operate the Commercial Kitchen Ventilation Research Laboratory in Wood Dale, Illinois, a suburb of Chicago.

Architectural Energy Corporation's professional services derive from a number of core competencies. These are:

- Monitoring and diagnostic testing
- Energy modeling and analysis
- Energy engineering
- Electronic hardware development
- Technical writing
- Education and training
- Software engineering
- Lighting modeling and analysis
- Air flow modeling and analysis
- Flow visualization
- Code and standards
- Customer support

The professional services provided by AEC, and described below, combine these core competencies into unique customer solutions for a wide range of energy engineering problems.

8.1.2 AEC's Services

Sustainable Design Assistance

AEC works with building owners and developers, architects, and engineers to design energy efficient, daylit and sustainable residential, commercial, and institutional buildings. These exemplary, world-class buildings typically have annual energy costs 30 to 50 percent less than buildings designed to meet the local energy code, and achieve high levels of comfort and indoor environmental quality.

Using the latest design methods and simulation software, AEC integrates daylighting into the form and fabric of buildings, consults on HVAC and lighting system design and shell construction, and performs economic analysis of alternative energy efficiency and sustainable design solutions. AEC, as a member of the U.S. Green Building Council, uses the Leadership in Energy and Environmental Design (LEED) rating system as a guide for sustainable design, and prepares documentation for LEED certification.

Building Commissioning and Diagnostic Testing Services

Commissioning by AEC's engineers is a comprehensive and systematic process to verify that the building's HVAC, lighting, and energy management and control systems function completely as designed. AEC commissions both new and existing buildings, using its patented building diagnostic tools to find operational performance problems. AEC's commissioning process involves an active communication process among the owner, architect, engineers, general contractor and subcontractors, and building operators. Commissioning improves the operation of the building's systems, reduces energy consumption, and improves comfort and indoor air quality.

Utility and ESCo Services

AEC provides electric and gas utilities with a variety of building energy engineering services, including load research, product assessment, DSM program impact evaluation, and market transformation. Recent or ongoing projects include market transformation activities in California, evaluation of interruptible load programs in Minnesota and Colorado, and load research in Thailand.

AEC works with energy services companies (ESCos) to baseline building energy consumption and costs, diagnose building operational performance problems, conduct energy conservation measure (ECM) analysis, commission ECM measures, and measure and verify performance. ESCo engineering services have been provided on a wide range of building types, including schools, hospitals, research laboratories, military facilities, State and Local government facilities, office buildings, courthouses, and correctional facilities.

Building Science Research and Development

AEC conducts a broad spectrum of energy and environmental research and development activities for government agencies, utility companies, professional and industry associations, and private for-profit companies. Research and development activities include building energy analysis tools, automated HVAC diagnostic techniques, advanced load management and control methods, alternative cooling technologies and strategies, and building integrated photovoltaics and other renewable energy systems.

Since 1983, AEC has conducted research at its Commercial Kitchen Ventilation (CKV) Research Laboratory outside Chicago, Illinois. Research at the CKV laboratory has been the basis for improved design standards for commercial kitchen ventilation systems, and has advanced the understanding of commercial cooking appliance operation, heat gain from cooking appliances to the conditioned space, and appliance energy efficiency.

Product Development Services

AEC develops energy-related products, software, and services, under contract with a variety of organizations and companies. Recent or ongoing product development assignments include the following:

- Comfort Advisor Measurement Unit™ available through myFacilities.com for the in-situ assessment of indoor comfort conditions in customer facilities.

- Watt-Wiser™ wireless plug-load monitoring system for the Electric Power Research Institute to conduct load research in residential and commercial buildings.

- D-Gen Pro™ distributed generation economic screening software in cooperation with the Gas Technology Institute to assess the feasibility of microturbine, fuel cells, reciprocating engine, and other on-site power generation systems.

- Mini Optical Light Shelf (MOLS) daylighting system under DOE's Small Business Innovation Research Program. (U.S. Patent No. 6239910 B1)

8.1.3 AEC's Products

Architectural Energy Corporation has developed a number of hardware and software products to support the design, commissioning, and operation and maintenance of energy efficient residential and commercial buildings.

The professional products developed, marketed, and supported by Architectural Energy Corporation are described below.

MicroDataLogger® Portable Data Acquisition System

The MicroDataLogger® portable data acquisition system is a four-channel, battery-powered data logger and associated analog and digital sensors, designed specifically for building energy performance monitoring. Its small size and flexibility enables the MicroDataLogger system to be used for a variety of field monitoring and diagnostic testing applications. The MicroDataLogger hardware is used as the data collection platform for AEC's ENFORMA® diagnostic and commissioning software, described later. A recent improvement to this system is MDL-Remote™, which allows communications with MicroDataLogger units over the telephone.

MicroDataNet® Wireless Data Acquisition System

Using the latest low-power, wireless technology, AEC has developed the MicroDataNet Wireless Data Acquisition System. Battery-powered, wireless analog and digital sensors transmit their values to a gateway which, through a wireless modem, transmits these data via the Internet to AEC's or the customer's server, where application and data visualization software processes the data and delivers it, via the world wide web, to authorized users.

The MicroDataNet Wireless Data Acquisition system ushers in a new paradigm of performance monitoring, evaluation, and diagnostic testing, providing exceptional ease of installation, flexibility, data analysis, and information availability.

ENFORMA® Diagnostic and Commissioning Software

The ENFORMA software is the first commercially available integrated, portable system to diagnose the operational performance of HVAC, lighting, and control systems. The software is designed to interface with the MicroDataLogger data acquisition system. It assists users to plan the measurement process, collect the required measurements, and analyze and report the data as information to the user. The ENFORMA process is patented (U.S. Patent 5,481,481). Applying the ENFORMA process typically uncovers problems too difficult to identify using traditional test methods, giving credence to the ENFORMA marketing phrase "The difference between I 'think' and I 'know.'" [sm]

D-Gen Pro™ Distributed Generation Economic Screening Software

D-Gen Pro is the premier software tool for determining economic feasibility of distributed power generation, including microturbines, fuel cells, reciprocating engines, and other on-site power generation systems. Working in conjunction with Gas Technology Institute, AEC developed D-Gen Pro softwre to quickly and easily evaluate the cost-effective application of on-site and distributed power generation. It is an excellent tool for corporate facility managers, gas and electric utility representatives, energy service companies, and distributed power generation equipment manufacturers.

REM/Design™ and REM/Rate™ Residential Energy Analysis, Code Compliance and Rating Software

REM software is designed for use by homebuilders, home designers, energy consultants, home improvement contractors, utilities, weatherization agencies, and home energy rating organizations. Two versions of the REM software have been developed: REM/Design™ and REM/Rate™.

- REM/*Design*™: This user-friendly, yet sophisticated, Windows-based software helps homebuilders, home designers, energy consultants, and home improvement contractors to improve the energy efficiency of new and existing homes. It calculates heating, cooling, domestic hot water, lighting and appliance loads, consumption, and costs based on a description of the home's design and construction features and local climate and energy cost data. The software also calculates heating and cooling design loads for sizing mechanical equipment, and determines if the home's design complies with the applicable energy code or standard. Over 15 reports are created by the software.

  Custom versions of REM/*Design* have been created for industrial and utility clients: REM/Gold (Johns Manville), REM/Energy Crafted Home (Consortium of New England Utilities), REM/EEBA (Energy Efficient Building Association), and

REM/MH (Johns Manville). Version 10.1 is the most current commercially released version of REM/*Design*.

- REM/*Rate*™: This user-friendly software is used by organizations which operate energy rating systems (HERS). HERS rate the energy efficiency of homes for purposes of identifying cost-effective improvements and providing energy-efficient mortgages. Primary and secondary lenders have created energy-related financial products which rely on HERS establishing the existing or future energy efficiency of a home. A rating tool, such as REM/*Rate*, is used to establish an unbiased, objective indication of a home's energy efficiency using uniform and consistent assumptions and procedures. REM/*Rate* complies with the U.S. Department of Energy Voluntary Home Energy Rating Guidelines (10 CFR 437) and NASEO/RESNET HERS Technical Guidelines.

Mini Optical Light Shelf Daylighting System

To encourage the widespread use of daylighting in commercial buildings, Architectural Energy Corporation invented and patented the mini optical light shelf (MOLS) daylighting system. MOLS is a daylight redirecting system which receives daylight from a wide acceptance angle, and reflects this daylight onto the ceiling deep in the daylit space. MOLS, designed to work at all North American latitudes, saves energy by turning off or dimming electric lighting, and reducing cooling loads, while providing uniform, indirect ambient lighting.

AEC is uniquely qualified to conduct the California Building Energy Initiative. We developed the concept for the program and conducted the CBEI Pilot Program with SCE in 2001. The pilot demonstrated the cost-effective potential for the CBEI to reduce energy consumption in California, which gives us confidence that the CBEI funded by the CPUC will be successful. Much of the technology used to perform the engineering activities for the CBEI was developed by AEC. This includes the MicroDataLogger® portable data acquisition equipment, the ENFORMA® data analysis software, the Survey-IT™ and Model-IT™ software used to create building energy simulation models, and the MicroDataNet™ system used to continuously monitor performance after the improvements are made to the buildings.

8.1.4 Summary and References

AEC has demonstrated its ability to design and implement large energy efficiency programs, including a PIER-funded research program for the CEC and a countrywide load research program in Thailand. AEC is one of three organizations selected by the CEC in 1999 to manage large research contracts. AEC's contract is more than $5.5 million. Research started in 2000 and will continue into 2003. The CEC managers have complimented AEC on our program management skills. In 1998, AEC was selected as a member of a team led by the Electric Power Research Institute (EPRI) to conduct load research in Thailand. Our role was to collect information on building characteristics, end-use electrical devices, and end-use energy consumption for all customer classes (commercial, residential, and industrial) in all parts of the country. We quickly assembled a highly qualified team of engineers, trained them, and managed their activities during the two-year project. We completed our work on time and within budget.

AEC has done a great deal of work in California and has developed contacts in the key industries necessary for the successful conduct of the CBEI. We have a group of engineering firms with whom we conduct projects. Many of them will be subcontractors to AEC on the CBEI. We have relationships with program and contracts personnel at all the IOUs. These will help to make the contracting process go smoothly, and will help to coordinate the CBEI with energy efficiency programs conducted by the utilities. We also have contacts in all of the major industries that are targets for the CBEI. We will leverage these contacts as we implement the program.

Finally, as a consulting firm with 20 years of experience serving the needs of our clients, AEC is a well-established business with an existing infrastructure of support functions (such as clerical, legal, and accounting), facilities, and office equipment. We have commercial technology (such as the MicroDataLogger system and ENFORMA software), and proprietary technology (such as Survey-IT, Model-IT, and the MicroDataNet system) needed to cost-effectively conduct the CBEI program. We also have the relationships (with subcontractors, utilities, California government agencies, and potential participants) that will allow us to efficiently improve building energy performance, reduce energy consumption, and meet the Commission's policy objectives.

The following references may be contacted to obtain information about Architectural Energy Corporation:

Ms. Nancy Jenkins, P.E.
Director – PIER Buildings Program
California Energy Commission
(916) 654-4739

Mr. Mark Martinez
Manager, Technical Services
Southern California Edison
(626) 302-8643

Mr. Jeff Johnson
Executive Director
New Buildings Institute
(509) 493-4468 x13

Ms. Alyssa Newman
Program Manager, Commercial New Construction
Pacific Gas & Electric Company
(415) 973.4285

Ms. Lisa Fabula
Program Manager, Commercial New Construction Energy Efficiency Programs
San Diego Gas and Electric Company
(858) 636-5740

8.2 Qualifications of Proposed Subcontractors

8.2.1 CTG Energetics, Inc. (CTG) (www.ctg-net.com)

CTG Energetics, Inc., located in Irvine, California, is an affiliate of Constructive Technologies Group which performs energy consulting and sustainable design services for design teams, building owners, property managers, contractors, and utilities. CTG's founder and president, Dr. Malcolm Lewis, has been a leader in the design and development of energy-efficient buildings for over twenty years. He heads a team of experts who bring experience and technical knowledge to the problem of introducing leading edge concepts into "real world" designs. The CTG Energetics mission is to assist our clients in producing buildings and building systems that are functional, cost-effective and maintainable as well as being innovative and sustainable.

CTG Energetics Project Roles include:

- Conceptual development of energy efficiency and sustainability measures.
- Energy analysis including computerized evaluation of alternative designs.
- Training our clients and other professionals in the application of energy efficient building design strategies.
- Evaluating energy problems and developing energy saving strategies for new and existing facilities.
- Evaluation and negotiation of power procurement alternatives in the restructured utility environment.
- Peer review of engineering designs and analyses for energy efficient and sustainable building projects.
- Commissioning of building systems to assure that actual system performance matches the original design intent.

CTG Energetics' staff has experience designing and consulting for facilities with sophisticated mechanical, electrical, and information systems including cogeneration, daylighting, energy management and control systems (EMCS), Thermal Energy Storage (TES), solar heating, photo-voltaic systems, heat recovery, district heating and cooling, and energy-conscious architectural design.

CTG Energetics' Integrated Approach to sustainable design is aimed at minimizing the way the built environment impacts the natural environment. This includes considering issues of energy efficiency, renewable materials, closed cycle waste processing systems, efficient transportation, water and wastewater systems, and sensitive use of the land. We know from experience that the energy consumption, energy costs, and environmental impact of the built environment can be reduced dramatically while simultaneously improving (not sacrificing) indoor comfort, indoor air quality, and building aesthetics.

CTG Energetics' Economic Analyses examine the lifecycle costs and impacts of building design alternatives, not just the initial cost or the annual expenses. We provide value to our clients over the life of their facilities and identify solutions and technologies that withstand the tests of time.

CTG Energetics will participate in the field studies, engineering analysis, and development of energy efficiency recommendations.

The following references may be contacted to obtain information about CTG Energetics, Inc.

Carey McLeod
AC Martin Partners
(213) 683-1900

Susan Munves
City of Santa Monica
(310) 458-8229

8.2.2 RLW Analytics, Inc. (RLW) (www.rlw.com)

Dr. Roger L. Wright, President of RLW, first founded Roger L. Wright and Associates in 1970. In 1989, Dr. Wright left the position of Statistics and Management Science Department Chair at the University of Michigan Graduate School of Business Administration, and joined Curt Puckett of Consumers Power Company to form RLW Analytics, Inc. Since then, RLW has grown to more than 30 full-time employees at four offices in California (Sonoma), Michigan, Connecticut and New York.

RLW is a recognized industry leader in providing innovative analytical, engineering and market research consulting for energy companies and organizations. Our consultants are experts in energy auditing and DOE-2 modeling, load research and load monitoring, statistical sampling, econometrics, energy analysis, market research, software development, and project management. We have collected detailed information at thousands of residential, commercial and industrial sites, built thousands of DOE-2 models, implemented numerous telephone surveys, and statistically summarized the resulting information it meaningful terms for each project. Our Shape-IT™ and Compare-IT™ software tools are designed to help users make profitable energy supply and equipment retrofit decisions. Our Electric Markets Survey provides users with current market intelligence on the deregulated electric marketplace.

RLW's other innovations include the Model-Based Statistical Sampling (MBSS™) Software for sample design and analysis, and the Engineering Calibration Approach (ECA™) for understanding the energy use of market segments. In addition, RLW Analytics has brought a new dimension to load research analysis with Visualize-IT™. This powerful 3-D data visualization tool enables the efficient editing, analysis and presentation of metered load data.
RLW Analytics has a simple corporate purpose, encompassed in its mission statement:

RLW Analytics will participate in the field studies, engineering analysis, and development of energy efficiency recommendations.

The following references may be contacted to obtain information about RLW Analytics, Inc.

Marian Brown
Manager, Measurement & Evaluation
Southern California Edison
(626) 302-8281

Valerie Richardson
Supervisor M&E
Customer Energy Management
Pacific Gas & Electric Co.
(415) 973-6163

8.2.3 Eley Associates (Eley) (www.eley.com)

Eley Associates, an architectural and engineering consulting firm located in San Francisco, was founded by Charles Eley in 1976 and incorporated in 1994. Eley's practice is devoted to advancing energy efficiency in buildings through energy policy development, technical research, building energy and cost analysis services, software development, professional training and communications. Eley Associates has an interdisciplinary staff of nine professionals and close association with technical sub-consultants with special areas of expertise. Eley's offices are centrally located in downtown San Francisco.

Eley Associates offers a broad scope of energy consulting services to architects, engineers, developers, building owners, utilities, professional associations and government agencies. The firm maintains a wide range of design and analysis tools that can be applied to the solution of specific building problems or to the performance assessment of whole building systems. Staff has extensive experience in engineering, computer modeling and energy use simulation in building design. Eley's goal from the outset has been to apply technical knowledge and design experience to achieve more energy efficient environments. A thorough understanding of the building industry as well as understanding of the planning and regulatory processes complement Eley's technical skills.

Eley Associates will participate in the field studies, engineering analysis, and development of energy efficiency recommendations.

The following references may be contacted to obtain information about Eley Associates.

Charlie Nadig
Senior Project Manager
PG&E
(415) 973 4790

Scott Wentworth
Energy Engineer
City of Oakland
(510) 615 5421

8.2.4 Portland Energy Conservation Inc. (PECI) (www.peci.org)

PECI is a non-profit corporation, located in Portland, Oregon, that specializes in innovative approaches to energy and resource efficiency, by offering a unique combination of expert research, policy development, program design, and on-the-ground client services. PECI's staff has extensive experience in engineering, education, marketing, and research.

As the founder of the National Conference on Building Commissioning, PECI has catalyzed much of the discussion, research and development of quality assurance strategies for commercial buildings in the United States. PECI builds the infrastructure for expanding commissioning by developing standardized tools, guidelines, and training for both building owners and commissioning providers. PECI also conducts market research, which informs their design of market transformation programs. In addition, PECI has a solid track record of providing building commissioning and diagnostics services to building owners and the commissioning industry. PECI's work routinely includes:

- Conducting the annual National Conference on Building Commissioning (since 1993).
- Developing and producing handbooks, guidebooks, and guidelines on commissioning and O&M.
- Researching and documenting "standard" and "best" practices for O&M, commissioning, and energy-responsive design.
- Designing and producing informational brochures on commissioning and O&M.
- Designing and delivering workshops and training programs for utility staff, commissioning providers, and operation and maintenance staff.
- Designing and conducting surveys of commissioning service providers.
- Commissioning new and existing buildings of virtually all types and sizes.
- Conducting site surveys and energy audits to identify energy-savings potential.
- Defining strategies for integrating energy efficiency into current construction and building-operation practices.

PECI has also designed and managed numerous market research and transformation programs. Their implementation experience includes negotiating and managing contracts with multiple parties, creating and tracking program budgets, administering manufacturer incentives and salesperson spiffs, overseeing the production of program marketing materials, conducting education and outreach to targeted audiences, and providing the technical assistance and market research to support market change. This includes:

- Building extensive relationships with a network of more than 500 retailers, distributors and manufacturers, enabling us to achieve a swift, tangible presence in the market.
- Designing creative, effective retail programs that generate outstanding market results based on our broad market knowledge and analysis of existing conditions.
- Advertising, public relations, education, special promotions and sweepstakes development that provides a solid understanding of consumer behavior and message effectiveness.

- Paying attention to detail while continuing to monitor the progress of long-term goals gives PECI the ability to expertly manage and administer programs in a rapidly changing business environment.
- Accurate, effective distribution of financial resources to achieve goals in manufacturer rebate programs where millions of dollars are allocated and managed fluidly.
- Conducting extensive research to characterize markets, analyze consumer trends, and evaluate opportunities for growing the market.

PECI will participate in marketing, recruiting, process improvement activities.

The following references may be contacted to obtain information about Portland Energy Conservation, Inc.

Matt Brown
Assistant Project Manager
NYSERDA
(518) 862-1090 x 3336

John Jennings
Project Coordinator
Northwest Energy Efficiency Alliance
(503) 827-8416 x 229

8.2.5 Eskinder Berhanu Associates (EBA)

Eskinder Berhanu & Associates (EBA) is an independent consulting and engineering firm specializing in energy efficiency projects. EBA expertise extends from performing building energy simulations of commercial, residential and institutional sites; to collecting extensive energy end-use data for utility DSM programs, as well as customized projects. EBA also performs verification of savings and installation of ECM's and Title 24 compliance checks for a variety of private, government, and educational organizations.

Eskinder Berhanu & Associates staff offers tremendous experience in energy consulting, having spent more than 12 years in performing complex DOE-2 analyses; managing and conducting extensive energy surveys and audits; and analyzing and reporting the results to guide appropriate energy conservation measures. Whether working directly with the client, or being a member of a multiple-consultant team, EBA is highly qualified and adaptable in a number of tasks to ensure quality results. Eskinder Berhanu & Associates is a certified minority-owned business (MBE). Services provided by EBA are described below.

Eskinder Berhanu & Associates will participate in the field studies, engineering analysis, and development of energy efficiency recommendations. References for them are:

Douglas Mahone, Partner
Heschong Mahone Group
(916) 962-7001

Marc Hoeschele, Senior Engineer
Davis Energy Group, Inc.
(530) 753-1100

8.3 Personnel Resumes of Description of Relevant Experience

Donald J. Frey, P.E. will be the Principal-In-Charge of the CBEI program. He has been in the building energy efficiency business for more than 25 years, and, together with Michael Holtz, AIA, founded AEC in 1982. He participated in the development of many of the technologies that will be used in the CBEI program, and was Principal-In-Charge of the CBEI Pilot Project. In addition, he is currently in charge of projects that are being conducted under contract to the CEC and each of the IOUs in California. He has experience negotiating and managing contracts with the IOUs. A highly qualified and professional staff of engineers from AEC will work with Mr. Frey to conduct this program. Experienced subcontractors are also part of the program team. Over one-third of the members of the team are licensed engineers or architects, and over half have advanced degrees. Resumes for project team members are presented below.

8.3.1 Architectural Energy Corporation

Donald J. Frey, P.E., Executive Vice President

Donald Frey has been engaged in business management, project management, engineering, and energy-related research and design for over twenty-five years. Together with Michael Holtz, he founded Architectural Energy Corporation in 1982, after serving as owner of Architectural Energy Consultants, a project manager at the Solar Energy Research Institute, and Senior Engineer of Applied Science and Engineering. Mr. Frey's work has focused on the development and application of innovative building performance evaluation techniques, including the DOE/SERI Commercial End-Use Monitoring Project; ENFORMA® diagnostic, commissioning and evaluation system; and the MicroDataLogger® portable data acquisition system.

Mr. Frey recently managed a complex project conducting electric load research on residential, commercial, and industrial customers in Thailand. He developed the concept for the California Building Energy Initiative (CBEI), a Third-Party Initiative funded by Southern California Edison and the State of California. He managed the CBEI Pilot Project. He continues his involvement and commitment to performance evaluation, energy research, and diagnostic testing through research and demonstration projects with utilities and private industry clients. He is currently responsible for managing development of the MicroDataNet™ wireless data acquisition system.

- Master of Science, Civil Engineering, University of Colorado; Boulder, CO; 1975
- Bachelor of Science, Aerospace Engineering, University of Colorado; Boulder, CO; 1971
- State of Colorado, Registered Professional Engineer, No. 13960
- Member, American Society of Civil Engineers
- Member, Professional Engineers of Colorado
- Member, National Society of Professional Engineers

Michael J. Holtz, AIA, NCARB, President
Michael Holtz co-founded Architectural Energy Corporation in 1982. Together with Donald Frey, P.E., Mr. Holtz oversees all business operations of AEC, including business administration and development, and project-related activities. He participates in defining the scope of services, ensuring resource availability and attending and actively participating in project meetings and activities. Mr. Holtz works with the project manager to ensure that AEC fully meets its commitments and obligations to the client, as well as provides quality assurance review of the work products created by the AEC team.

Mr. Holtz has worked full time in energy research, development and design consulting since 1972. He has designed or consulted in the design of hundreds of energy efficient, sustainable residential, commercial, and institutional buildings, and actively participating in organizations promoting sustainable design.

- Master of Architecture; State University of New York; Buffalo, NY; 1974
- Bachelor of Architecture; Ball State University; Muncie, IN; 1971
- State of Colorado and District of Columbia, Registered Architect
- NCARB Certificate No. 2l,799
- Member, American Institute of Architects
- Member, American Institute of Architects National Committee on the Environment
- Member, Association of Energy Services Professionals
- Member, U.S. Green Building Council
- Operating Agent, International Energy Agency
- Member, American Solar Energy Society
- Member, International Solar Energy Society

Peter C. Jacobs, P.E., Senior Engineer
Peter C. Jacobs has been involved in energy efficiency and renewable energy research, development, and manufacturing since 1979, and serves as technical lead for AEC's codes and standards, market transformation and evaluation studies across the nation. He is leader of AEC's ESCO/Utility Services Business Area Team. He is project manager for an element of a California Energy Commission (CEC) Public Interest Energy Research (Pier) project, focusing on improving the efficiency of small commercial HVAC systems. He conducted research for Pacific Gas and Electric Company (PG&E) into improvements to HVAC system controls as a part of a recent Codes and Standards Enhancement (CASE) initiative, and was responsible for calculating the energy consumption and peak demand impacts of the CEC AB 970 2001 update to Title 24 non residential energy standards.

- Master of Science, Mechanical Engineering, Colorado State University; Fort Collins, CO; 1982
- Bachelor of Science, Mechanical Engineer, Penn State University; State College, PA; 1975

- State of Colorado, Registered Professional Engineer, No. 25440
- Member, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
- Member, American Solar Energy Society

Stuart S. Waterbury, P.E., Senior Engineer
Stuart Waterbury is responsible for project management, engineering analysis, software development, and instrumentation for building energy analysis and energy services contracting projects. Projects have included HVAC diagnostics and commissioning, load research, and estimation of baseline and post-retrofit HVAC and lighting energy usage from short-term monitoring. He has worked extensively on development and use of the ENFORMA® diagnostic system, an integrated hardware and software system for fault detection, diagnostic testing, and performance evaluation of HVAC and lighting systems. He is currently developing automated methods for detecting faults in HVAC systems, as part of a PIER-funded contract with the California Energy Commission.

Mr. Waterbury has evaluated the performance of many roof-top units and developed methods for evaluating economizer performance. He has analyzed packaged economizer performance on units ranging from small 3-ton single zone units up to "boxcar" units of hundreds of tons. Much of the results of this work has been incorporated into the ENFORMA HVAC Analyzer software.

Prior to AEC, Mr. Waterbury was employed by BDM where he was a thermal analyst for many projects in government and industry. He was also responsible for developing computer simulation models of solar thermal power plants, as well as advanced concentrating collector designs.

- Master of Science, Mechanical Engineering; Colorado State University; Fort Collins, CO; 1982
- Bachelor of Science, Mechanical Engineering, University of Nebraska; Lincoln, NE; 1977
- State of New Mexico, Registered Professional Engineer, No. 9688
- Member, American Society of Mechanical Engineers
- Member, American Society of Heating, Refrigerating, and Air-Conditioning Engineers

Vernon A. Smith, P.E,, Senior Engineer
Vernon A. Smith is responsible for project management and engineering analysis for building science related projects. He also serves as corporate legal counsel for Architectural Energy Corporation. He has worked since 1978 in management, contract administration, engineering, scheduling, and cost control in construction, manufacturing, and engineering.

Since 1992, Mr. Smith's assignments at Architectural Energy Corporation have focused on building science and foodservice energy research. He is Program Director for a three year PIER Buildings Research Program titled "*Energy Efficient and Affordable Small Commercial and Residential Buildings*" sponsored by the California Energy Commission. He is also program manager for the Commercial Kitchen Ventilation Laboratory, under contract with the Pacific Gas & Electric Company and Fisher-Nickel, Inc.

Before joining AEC, he coordinated engineering and manufacturing support for PrairieTek; was vice president of the Denver office of Arkhon Corporation; and was senior engineer for Hill International. He was also a program manager for the Colorado Energy Research Institute, focusing on energy research projects involving the built environment.

- Master of Science, Business Management; University of Northern Colorado; Greeley, CO; 1980
- Juris Doctor, Rutgers-Camden Law School; 1977
- Bachelor of Science, Mechanical Engineering, Georgia Institute of Technology; Atlanta, GA; 1972
- State of Colorado, Registered Professional Engineer, No. 19299
- Colorado Supreme Court and U.S. District Court, No. 011964
- Member, American Society of Mechanical Engineers
- Member, American Society of Heating, Refrigeration, and Air-Conditioning Engineers
- Member, American Solar Energy Society
- Member, International Solar Energy Society
- Member, Colorado Bar Association
- Member, Boulder Bar Association

David R. Roberts, P.E., Senior Engineer
David Roberts heads the Information Technology Team, heads the Residential Energy Analysis Software Business Area Team, and provides building energy analysis for company research, demand-side management, and energy design consulting projects.

Mr. Roberts specializes in the use of the DOE-2 building energy simulation software, software design and development, and programming in C++, FORTRAN and Visual Basic. Mr. Roberts worked on the design and creation of a series of energy analysis software products developed for a leading insulation manufacturer, and continues to develop and support AEC's residential energy analysis software products. He uses the DOE-2 program for energy and economic studies such as the New Denver International Airport and University of Wisconsin design assistance projects, and numerous commercial demand-side management evaluation projects. He is the technical lead in the ongoing development and support of Survey-IT™ and Model-IT™, a commercial building audit database and companion application that automatically generates DOE-2 simulation models for use in baseline and program evaluation studies. Mr. Roberts was a member of the project team that investigated and authored an engineering handbook on evaluation methods for demand-side management projects for the Electric Power Research Institute.

- Master of Science, Civil Engineering (specializing in Building Systems Engineering); University of Colorado; Boulder, CO; 1992
- Bachelor of Science, Environmental Resource Engineering; Humboldt State University; Arcata, CA; 1989
- State of

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Michael T. Anstett, Senior Engineer

Michael Anstett, who joined the company in 1993, has been involved in computer software development for twenty years. He has an electrical engineering background, which he has applied in developing integrated hardware and software systems. He provides AEC with a strong capability in object-oriented software engineering, database design, and artificial intelligence. He is the in-house expert in software design and development. Currently working on web applications to analyze building and metering data. Mr. Anstett is responsible for directing or participating in all of Architectural Energy Corporation's software development activities. He is AEC's lead developer for database applications, with extensive experience in most industry database platforms.

- Master of Science, Engineer with emphasis in Building Energy Systems; University of Colorado; Boulder, CO; 1992
- Bachelor of Science, Computer Science; Central Connecticut State University; New Britain, CT; 1980

Fred W. Porter, Senior Engineer

Fred Porter serves as AEC's lead energy analyst on sustainable design assistance projects. He evaluates architectural, mechanical, electrical, and control energy efficiency improvements using state-of-the-art simulation software, such as DOE-2, TRNSYS, and EnergyPlus.

Mr. Porter has analyzed energy use and developed energy efficiency improvement recommendations for numerous building types – offices, educational, restaurants, supermarkets, laboratories, manufacturing facilities, medical , and residential. He has special expertise in analyzing innovative, energy efficiency HVAC systems.

Mr. Porter has worked full time in the building energy field since 1984 and has worked at Architectural Energy Corporation since 1991.

- Bachelor of Science, Architectural Engineering / Mechanical Systems and Solar Energy; Boulder, CO; 1982
- Member, American Solar Energy Society

Tracy M. Phillips, EIT, Staff Engineer

Tracy Phillips manages and assists with projects in the building energy and demand-side management. His responsibilities include project management, monitoring plan development, field installation and retrieval of monitoring equipment, energy analysis, diagnosing operational problems within commercial buildings, and performing preliminary and detailed energy studies of commercial buildings.

Mr. Phillips frequently develops DOE-2 building energy simulation models to assess proposed energy conservation measures for design assistance and building retrofit projects. Additionally, he utilizes his monitoring and diagnostic skills on existing buildings to calibrate models and uncover energy conservation opportunities. He was a member of the engineering team that

conducted the California Building Energy Initiative (CBEI) Pilot Program in Southern California Edison service territory.

Mr. Phillips joined Architectural Energy Corporation in 1996.

- Master of Science, Physics; Stevens Institute of Technology; Hoboken, NJ; 1994
- Bachelor of Science, Physics (minors in Mathematics and Computer Science); University of Richmond; Richmond, VA; 1993
- State of Colorado Registered Engineer in Training, 2000

Erik A. Jeannette, EIT, Staff Engineer
Erik Jeannette is on the Design Assistance and Commissioning and Diagnostics teams at AEC. Mr. Jeannette's background is well-rounded in mechanical systems, control systems, energy efficient design concepts, energy monitoring and sustainable design. He offers mechanical controls expertise and control troubleshooting skills, as well as experience with control system programming and energy management design schemes. Mr. Jeannette also provides assistance to the daylighting team by offering lighting control solutions that compliment the daylighting designs.

Mr. Jeannette's background includes managing ASHRAE funded building energy research projects involving indoor air quality issues, optimizing thermal energy storage control and various other university engineering research projects. He has worked with testing of neural networks in building control systems, and whole building diagnosticians. He has also been employed as a mechanical controls design engineer where he was responsible for the design, sequences, programming and commissioning of many control projects throughout the country. Often these projects were of the design-build type requiring mechanical engineering and controls engineering skills to solve the building's comfort or energy problems.

- Master of Science, Civil Engineering (emphasis in Building Systems); University of Colorado; Boulder, CO; 1997
- Bachelor of Science, Civil Engineering (emphasis in Environmental Engineering); University of Colorado; Boulder, CO; 1995
- State of Colorado Registered Engineer in Training, 1995
- Certified Type II & III Refrigerant Technician

John C. Wood, EIT, Staff Engineer
John Wood is on the AEC commissioning team. He also is involved in design assistance and analysis on AEC's Federal Energy Management Program (FEMP) projects and National Renewable Energy Laboratory (NREL) projects.

Mr. Wood has a marked interest in renewable energy implementation. He worked five years (1993-1998) on part time contracts with Sun Energy Systems in San Antonio building solar thermal collectors, installing, maintaining, and designing solar thermal systems. He also worked almost three years (1998-2001) with Jade Mountain in Boulder, Colorado as Appropriate Technology Access Facilitator, designing, installing, and facilitating the access to renewable

energy, water conservation, water purification, energy efficient appliances, lighting, and other "appropriate technologies for sustainable living."

He has four years of Testing, Adjusting, and Balancing experience with Professional Engineers' Balancing Laboratory in San Antonio, Texas (1994-1998). This experience includes several Air Force Base projects on which he was on the commissioning team, prepared the checklists, and lead the functional performance testing.

- Bachelor of Science, Engineering (minor in Math); Trinity University; San Antonio, TX; 1992
- Qualified Supervisor of the Testing, Adjusting, and Balancing of Air and Hydronics Systems; National Environmental Balancing Bureau
- Certified for Photovoltaic and Solar Thermal System Design and Installation, Colorado Solar Energy Industries Association
- Member, Colorado Environmental Balancing Bureau
- Member, Colorado Solar Energy Industries Association

Kosol Kiatreungwattana, Staff Engineer
Kosol Kiatreungwattana, is engaged in field energy auditing, load research, and performance monitoring activities at Architectural Energy Corporation. Mr. Kiatreungwattana brings education and experience in HVAC design and analysis, building energy analysis, diagnostic testing, and software engineering. Mr. Kiatreungwattana is experienced in Fortran, C, C++, Visual Basic, and UNIX languages, and uses the ASEAM, DOE-2, ENERGY-10 and other building energy analysis simulations. He has developed energy analysis software, including a program to simulate the behavior of and performance of an indirect ice storage system.

- Master of Science; Civil, Environmental, and Architectural Engineering (Building Energy Systems); University of Colorado; Boulder, CO; 1998
- Bachelor of Science, Mechanical Engineering; Kasetsart University; Bangkok, Thailand; 1993
- Member, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)

John J. Browne, Hardware Manager
John J. Browne has more than 25 years of experience with the design and production of electronic products. He brings strong capabilities and understanding of the stringent requirements necessary to design and manufacture products which can compete in the marketplace. He is responsible for the hardware development and production of AEC's MicroDataLogger® product line. He is responsible for the design, manufacturing and testing of data acquisition systems and other scientific instruments used in AEC's research projects.

Mr. Browne has worked for a number of successful electronics companies and as Product Design Consultant. These include the OptiVideo Corporation where he was the Engineering Services Manager and Rela Inc as the Hardware Manager. At OptiVideo, Mr. Browne assisted the founder in starting the business. He developed concepts for a fiber optic switch actuator. He constructed electromechanical prototypes, prepared documentation, performed electronic and

optical testing, and helped develop an automated production process. He was the Hardware Manager at Rela Inc. as well as a principal in this electronic product development firm. He was responsible for the management of the electronics laboratory, technical library, and for purchasing. He supervised technicians and subcontractors.

Mr. Browne has been interested in electronics all his life. He received extensive vocational training in high school, and went on to pursue an electrical engineering degree at the University of Colorado. After one semester of college, he was offered a job at the University as an electronics design technician. He has worked in the field ever since.

- Studies in Electrical Engineering, University of Colorado; Boulder, CO; 1967
- Studies in Philosophy and Theology, Holy Cross Abbey; Canon City, CO; 1964

Judith E. Porter, CEM, Account Manager
Judith Porter has been involved in the energy industry since 1982. At AEC, she is responsible for providing utility-related market transformation work, working on marketing activities in the distributed generation industry, and working with clients to identify how AEC can best meet their needs. Her extensive experience in the energy field and electric utility industry helps AEC to develop and complete innovative client projects.

For example, Ms. Porter completed a project to produce quarterly newsletters to specific customer markets and develop design briefs for three major utility clients. As the project manager, she helped develop the themes and ideas, provided content and editorial review, coordinated printing and distribution, and provided budget administration.

Additionally, Ms. Porter is involved in numerous Internet activities. She develops and maintains the AEC web site in support of the company's mission and objectives, and has completed several client projects that involved creating web-based activities, information pages, and virtual learning courses.

Previously, Ms. Porter worked in the performance-contracting field identifying the best opportunities for facility improvement projects. She worked directly with clients to develop sound financing options for energy cost reduction projects while increasing the quality and comfort of their facilities. Her background includes extensive work with TU Electric, a subsidiary of Texas Utilities (TxU), where she worked with commercial and residential customers on energy usage, and designed and coordinated electric service.

- Bachelor of Science, Communications; Texas A&M University; College Station, TX; 1981
- Lighting, HVAC & Geothermal Systems Courses, Texas Utilities Electric Company, 1982-1995
- Direct Demand Side Management Marketing, Electric Power Research Institute, 1990
- HTML, JavaScript, and Internet-based courses, University of Colorado Continuing Education, 2000-2002
- Certified Energy Manager, Association of Energy Engineers
- Affiliate Member, Association of Energy Engineers (AEE)
- Affiliate Member, Rocky Mountain Association of Energy Engineers (RMAEE)

Jessica L. Bowen, Associate Engineer
Jessica Bowen is a member of the Utility and ESCO Business Area Team of Architectural Energy Corporation. As an Associate Engineer she is responsible for audits, data logger installation and retrieval, and data analysis. She is also responsible for energy and economic analysis of energy conservation measures, and for preparing reports. She is participating in projects to investigate the effectiveness of load curtailment projects for a major utility and a retrocommissioning project for another utility.

- Associate of Applied Science, Energy Management; Lane Community College; Eugene, OR; 2000

8.3.1 CTG Energetics, Inc.

Dr. Malcolm Lewis, P.E., President and Founder, CTG Energetics, Inc.
Dr. Lewis is a consulting engineer who specializes in mechanical, electrical, and energy systems for buildings and industrial processes. He has specialized experience in the introduction of innovative building technologies and design processes. These include energy efficiency, sustainable building design, daylighting, thermal energy storage, and cogeneration facilities. Dr. Lewis has over 30 years of experience in engineering design and the analysis of energy-using systems in buildings. He is the engineer of record for hundreds of new construction and renovation projects, for both public and private sector facilities. These facilities total over 25 million square feet.

Dr. Lewis has served as the sustainable design consultant for over 100 projects. He leads a team devoted to sustainability and high performance building design. Dr. Lewis has been responsible for the design of energy-efficient facilities including central plants with Thermal Energy Storage up to 20,000 Ton-Hours, cogeneration and power generation facilities up to 2.5 Megawatts, and buildings up to 250,000 SF that incorporate daylighting and high-efficiency HVAC and lighting systems. His past project work has included such diverse technologies as fuel cells, active and passive solar heating and cooling, wind power, photo-voltaic power and underfloor air distribution.

Dr. Lewis has served as peer reviewer for numerous energy-conscious design projects throughout the United States and abroad. He has been an energy consultant to the State of California Office of Energy Assessments, The World Bank, Southern California Edison Co., Los Angeles Department of Water and Power, and Southern California Gas Co.

Dr. Lewis served as a consultant for U.S. Department of Energy (1982 to 1995), performing peer reviews of new facilities designs at various DOE facilities, including National Renewable Energy Laboratory in Golden, CO. He has also participated in various DOE policy reviews, including development of Research & Development strategies and Technology Transfer projects.

- Bachelor of Science, Engineering Science, Harvey Mudd College; Claremont, CA; 1967
- Diploma, Housing/Building/Planning, Bouwcentrum; Rotterdam, The Netherlands; 1970
- Doctor of Engineering, Dartmouth College; Hanover, NH; 1971
- State of California, Mechanical Engineer No. M20954

- State of California, Electrical Engineer No. E11364
- State of California, Civil Engineer No. C29397
- A registered Professional Engineer in various other states (AZ, NV, OR, WA)
- Certified Energy Manager, Association of Energy Engineers
- U.S. Green Building Council LEED™ Accredited Professional
- American Society of Heating, Refrigeration and Air Conditioning Engineers
- Association of Energy Engineers
- American Society of Plumbing Engineers
- Construction Specifications Institute
- U.S. Green Building Council
- Illuminating Engineering Society of North America
- Member of ASHRAE Standard 90 Committee; 1983 to 1988
- Adjunct Professor, UCLA School of Architecture; 1994 to 1996
- U.S. Green Building Council: Board of Directors, 1997 to present; LEED™ Steering Committee, 2000 to present; Chair, LEED™ Technical & Scientific Advisory Committee, 2000 to present

Tom Lunneberg, P.E., Vice President
Tom Lunneberg provides energy efficiency consulting, analysis and training to a variety of commercial and institutional clients, and is responsible for managing the day-to-day activities of CTG Energetics, Inc.

Mr. Lunneberg has extensive experience in the evaluation of energy projects for cost effectiveness and performance verification and has provided analysis for numerous commercial, municipal, military, institutional, and healthcare facilities. He has conducted over five hundred energy audits throughout Southern California for a variety of commercial and industrial facilities. In addition, Mr. Lunneberg has provided training to a number of clients on topics of energy efficiency and energy management.

Mr. Lunneberg has authored numerous publications on a variety of energy efficiency topics, including three reports published by E SOURCE (“High Efficiency Laboratory Ventilation”, “Making Economizers Work”, “Tracking Chiller Plant Efficiency”). He has also written several design briefs under contract to AEC and published by Energy Design Resources (“Drivepower”, “Building Simulation”, “Chiller Plant Efficiency”, “Designing for Your Climate”, “Air-Side Economizers”). He has also written articles published by Energy & Environmental Management Magazine and the International Building Performance Simulation Association, and co-authored a chapter of the forthcoming fourth edition of the Energy Management Handbook, published by The Fairmont Press.

- Bachelor of Science, Mechanical Engineering, San Diego State University; San Diego, CA; 1991
- State of California, Mechanical Engineer No. M29399
- State of Colorado, Mechanical Engineer No. 31998
- Certified Energy Manager, Association of Energy Engineers
- State of California Certified Energy Plans Examiner (Commercial)

- Member, American Society of Heating, Refrigeration and Air Conditioning Engineers

Jerome M. Klipp, P.E., Senior Mechanical Engineer
Jerome M. Klipp specializes in the design of plumbing, fire protection, heating, ventilation, air conditioning, and energy conservation systems for the building industry. Mr. Klipp has over 50 years experience as owner and principal of consulting engineering firms. He has extensive experience with design of all mechanical systems for hotels, condominiums, high-rise structures, hospitals, regional shopping centers, and industrial plants. Mr. Klipp is experienced with design, specifications, and field supervision of cogeneration and power plant facilities for utility companies, industrial plants, and hospitals. He is also experienced with design and construction of environmental and process piping systems, propane gas plants, oil pipelines and bulk oil terminals for major oil companies.

In addition, Mr. Klipp has been the project manager and mechanical engineer for the design of central plants and building systems for complex facilities with severe environmental requirements. He has served as the mechanical and electrical engineer for a wide variety of educational facilities in Southern California as well as many other areas of the United States.

- Bachelor of Science, Mechanical Engineering, Illinois Institute of Technology; Chicago, IL; 1943
- Bachelor of Science, Electrical Engineering, Illinois Institute of Technology; Chicago, IL; 1947
- State of California Mechanical Engineer, No. M17956
- Previously registered in 28 states as both mechanical and electrical engineer.
- American Society of Heating, Refrigeration and Air Conditioning Engineers

Jerry Ingwalson, Project Manager
Mr. Ingwalson has provided energy efficiency consulting services to a variety of commercial and institutional clients. These services have included auditing, energy analysis, building commissioning, and program management. He has extensive field experience in evaluating the performance of existing systems. He has identified conservation opportunities and provided energy analysis and assessment of project cost effectiveness. He has conducted hundreds of energy audits throughout California and Nevada for a variety of commercial, municipal, military, and healthcare facilities.

- Bachelor of Science, Aviation Technology, Purdue University, 1991
- Associate Member, American Society of Heating, Refrigeration and Air Conditioning Engineers

Scott Duncan, P.E., Mechanical Engineering Consultant
Scot Duncan has over 20 years experience in controls, instrumentation, mechanical system synthesis, and mechanical system design as well as troubleshooting of existing mechanical and control systems. He has a specialized background in the design and analysis of energy efficient central plants and HVAC systems. Mr. Duncan is proficient in the analysis and design of Thermal Energy Storage (TES) systems and low temperature air distribution systems.

Mr. Duncan has been responsible for the design of thermal energy storage, energy management, and digital control systems for over 10,000,000 SF of commercial, industrial and institutional projects. Mr. Duncan's TES experience includes over 200,000 ton-hours of installed systems, including several of the largest TES systems in Southern California. Mr. Duncan has provided research, training and educational seminars regarding advanced TES, mechanical and control system design for the HVAC industry. He has also performed feasibility analyses and lifecycle costing analyses, and developed system design, startup, testing and troubleshooting procedures for energy systems in both new and existing facilities.

- Bachelor of Science, Mechanical Engineering, California State Polytechnic University; Pomona, CA; 1984
- Certificate, Honeywell Incorporated Computer Systems Engineering School; Minneapolis, Minnesota; 1979
- State of California, Mechanical Engineer No. M24280
- Certified Energy Manager, Association of Energy Engineers
- American Society of Heating, Refrigeration and Air Conditioning Engineers
- Past President Association of Energy Engineers, Southern California Chapter
- Member of ASHRAE Technical Committee No. 6.9, Thermal Energy Storage Design
- Past President (1990-1991) Association of Energy Engineers, Southern California Chapter
- Southern California Edison TES Design Assistance Team
- Los Angeles Department of Water and Power TES Design Assistance Team

Craig F. Hofferber, Consultant
Craig F. Hofferber specializes in mechanical and controls systems design, construction coordination and system commissioning. He has extensive experience in analysis, design and trouble shooting of large HVAC systems. He has over 29 years of experience in control and automation of facilities and their operations, with emphasis on HVAC central plants and air side systems, thermal energy storage, energy management systems, DDC systems, security, data communications, computer networking, video systems and automation.

Mr. Hofferber has been responsible for the design, coordination and commissioning for building automation systems at numerous commercial and institutional facilities. Responsible for establishing and maintaining engineering standards and quality control for the various engineering disciplines, particularly in the area of specifications and construction compliance with the design documents. He has been the principal commissioning agent for several landmark projects.

- Bachelor of Science, California State Polytechnic University; Pomona, CA; 1976
- American Society of Heating, Refrigerating and Air Conditioning Engineers - Member
- Director and Past President, ASHRAE Southern California Chapter
- Co-founder of the ASHRAE Tri-County Chapter
- American Society of Plumbing Engineers - Member
- Construction Specification Institute - Professional Member
- Instrument Society of America - Senior Member

Gail Stranske, E.I.T., Project Manager
Gail Stranske is responsible for energy engineering and software development activities including building energy simulation and analysis, energy auditing, and energy training software development. She has participated in energy audits of commercial and institutional buildings totaling over 2,500,000 SF. Her experience includes identification, analysis, and computer modeling of energy efficiency opportunities for new and existing facilities. Ms. Stranske has also conducted market research and assisted in developing efficiency standards and strategies for utilities and commercial property owners in Southern California and across the US.

- Bachelor of Science - Engineering, Harvey Mudd College; Claremont, CA; 1998
- State of California, Engineer-in-Training
- California Certified Energy Plans Examiner (CEPE), Residential & Nonresidential
- Certified CHEERS HERS Analyst

8.3.3 RLW Analytics, Inc.

Roger L. Wright, President
Dr. Roger Wright has consulted with business and industry since 1970. In 1989, he founded RLW Analytics as a successor to Roger L. Wright and Associates. Wright and RLW Analytics are noted for implementing practical and progressive methodologies in demand-side management evaluations, end-use data collection studies, and load research in the gas and electric utility industries. Clients include more than forty utility industry firms as well as more than a dozen firms in other industries.

At The University of Michigan, Dr. Wright taught business statistics, regression analysis, and sampling at all academic levels - BA, MBA, and Ph.D. Dr. Wright is also a principal instructor in the *AEIC Seminar on Advanced Sample Design and Analysis Techniques of Load Research.*

Dr. Wright's research is in statistical modeling, data analysis, and model-based statistical sampling. Applications include demand-side management evaluation, end-use information, load research, cost estimation, cost allocation, market segmentation, financial analysis and inventory control. Sponsors of Wright's research have included EPRI, DOE, The U.S. Department of Justice, General Motors, DeLoitte, Haskins and Sells, Consumers Power Company, and Consolidated Edison of New York.

Dr. Wright's work has included the development and practical application of several innovative statistical sampling and analysis methodologies. At the forefront of this work is the Model-Based Statistical Sampling (MBSS^{TM}) methodology for design and analysis of energy marketing, demand-side management, and load research projects. Most recently, Dr. Wright has applied the MBSS methodology to market segment analysis and DSM evaluation using the Engineering Calibration Approach (ECA^{TM}). ECA is a technique to measure and understand the energy use of a group of sites or a market segment by building and calibrating nested samples of engineering simulation models. ECA can also be used to evaluate the total impact of a DSM program by integrating an intense evaluation of a small sample of projects with results of other impact methods undertaken in the program. The ECA methodology includes an algorithm for the optimum allocation of resources among the various data collection strategies.

Dr. Wright has published more than twenty articles in The Journal of the American Statistical Association, The Journal of Business & Economic Statistics, Journal of Financial and Quantitative Analysis, Journal of Market Research, Auditing: A Journal of Practice and Theory and other leading journals. Many of these publications deal with load research and demand-side information development. He is also the author of two EPRI reports on load research, Model-Based Statistical Sampling for Electric Utility Load Research (1983) and Sample Designs for Load Research: The Bootstrap Comparison Procedure (1985). Wright has contributed papers regularly to EPRI's Load Research Symposium Series as well as the Annual Reports of the AEIC Load Research Committee.

- University of Notre Dame 1958-1960, mathematics.
- The University of Michigan 1960-1965, mathematics and statistics.
- Degrees: Ph.D. 1968, M.A. 1963, B.S. 1962: The University of Michigan.
- Member, Institute of Electrical and Energy Engineers (IEEE).
- Member, Association of Energy Services Professionals (AESP).

Matthew P. Brost, CEM, Western Regional Manager
Mr. Brost is a consultant and staff manager at *RLW's* Sonoma, California office. His responsibilities include project and office management, proposal and report writing, survey instrument design, on-site audits/surveys, end-use metering and building simulation techniques. Currently Mr. Brost is Project Manager for the Statewide Building Efficiency Assessment (BEA). The BEA study is a study of California Non-residential New Construction, and is being managed by Southern California Edison and the Heschong Mahone Group (HMG). In another project with H-M-G, Mr. Brost is manager of field staff for a Measurement and Evaluation contract with Sacramento Municipal Utility District (SMUD). The work includes M&V of eight energy efficiency programs currently being launched by SMUD.

Additionally, Mr. Brost is responsible for program elements under the Public Interest Energy Research (PIER) 3 Program, Integrated Energy Systems Productivity and Building Science. The two programs Mr. Brost is involved with for RLW include the California Commercial Outdoor Lighting Baseline Assessment and Small Commercial HVAC Systems. The outdoor baseline study is the first of its kind in California and will facilitate a better understanding of commercial outdoor lighting use and design, and will be used to aid in the development of energy codes and design guidelines. The HVAC study is an end-use study of small commercial packaged heating and cooling systems, the study is investigating th operational practices, maintenance issues and design and specification of these systems in California. RLW is under subcontract to Architectural Energy Corporation for this work.

- Sonoma State University, Spring 1996, BA, Environmental Studies and Planning
- Sonoma State University, Spring 1996, CA Certificate in Energy Management and Design
- Certified Energy Manager, Summer 2000
- Associate Member, Golden Gate Chapter ASHRAE
- Association of Energy Engineers (AEE)
- Illuminating Engineering Society of North America (IESNA)

Eric Swan, EIT, Consulting Engineer
Mr. Swan is a consulting engineer at RLW's Sonoma office. His primary responsibilities include on-site audits/surveys, end-use metering, building simulation techniques, evaluation of energy efficiency measures, and design of survey instruments. Additionally, his tasks include Title 24-energy code compliance, proposal and report writing.

Mr. Swan in the California Building Energy Initiative (CBEI) Pilot Program. The CBEI is a commercial building energy efficiency improvement project. For this project, Mr. Swan is conducting diagnostic end-use metering of large commercial building HVAC systems in order to perform thorough engineering analyses on the systems. This work is being done under subcontract to Architectural Energy Corporation.

Currently Mr. Swan is conducting on-site surveys, building simulation, and net to gross analysis for the Statewide Building Efficiency Assessment (BEA). The BEA study is a study of California Non-residential New Construction, and is being managed by Southern California Edison and the Heschong Mahone Group (HMG). In another project with HMG, Mr. Brost is manager of field staff for a Measurement and Evaluation contract with Sacramento Municipal Utility District (SMUD). Mtr Swan is helping to developed M&V protocols of eight energy efficiency programs currently being launched by SMUD.

Additionally, Mr. Swan is at work for two program elements under the Public Interest Energy Research (PIER) 3 Program, Integrated Energy Systems Productivity and Building Science, outdoor lighting and small HVAC. For the Small Commercial and Industrial HVAC element, Mr. Swan is responsible for the short term monitoring and analysis of sites utilizing rooftop package units.

- State of California, 1997, E.I.T. License No. XE103874
- San Francisco State University, 1999, B.S., Mechanical Engineering
- ASME - American Society of Mechanical Engineers
- ASHRAE - American Society of Heating, Refrigeration and Air-conditioning Engineers

8.3.4 Eley Associates

Charles Eley, FAIA, P.E., President
Mr. Eley, President of Eley Associates, is responsible for assuring the highest caliber of work to the firm's clients and for allocating staff resources accordingly. Mr. Eley is an architect, mechanical engineer, and energy consultant with more than 25 years experience. Fields of expertise include: computer programming and simulation; software development, building energy analysis (daylighting studies, active/passive solar design, etc.), energy policy and regulatory analysis; technical writing; and continuing education for design professionals.
Mr. Eley has devoted his practice to building energy conservation activities at the private sector, city, state and national levels. He has participated actively in the development of California's new energy codes, as well as those in Hawaii, American Samoa/Guam, New York, Arizona, Idaho, Washington, Hong Kong, Australia, as well as the national ASHRAE standard 90.1. He has advised utility companies on the development and implementation of energy incentive programs and is an active lecturer and instructor. Prior to founding the firm in 1976, Mr. Eley

worked as a project manager for several mainstream architectural firms. He also served as a design architect and urban designer at the Tennessee Valley Authority.

- Bachelor of Architecture, University of Tennessee, 1969
- Master of City Planning, University of California (Berkeley), 1973
- Licensed Architect, State of California
- Registered Mechanical Engineer, State of California
- American Institute of Architects, Fellow
- American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), member
- Illuminating Engineering Society (IES), associate member
- U.S. Green Building Council, member

Erik Kolderup, P.E., Vice-President
Mr. Kolderup is an energy engineer and policy analyst with expertise in identification and evaluation of energy efficiency measures in commercial buildings. He has extensive experience in building energy computer simulation and economic analysis. Mr. Kolderup joined Eley Associates in 1990, specializing in standards development and building component optimization. In the last three years, he has been responsible for managing a large share of the firm's work in energy and cost analysis services, including PG&E's ACT 2 Evaluation Program, SCE's New Construction DSM Verification Program, a cost database development project for use by utilities in forecasting and DSM, energy code and software development for the State of Hawaii, as well as a many projects to identify and evaluate energy savings measures for new and retrofit commercial buildings. Earlier experience includes development of a software-rating tool for a California Home Energy Efficiency Rating System, a fenestration research study funded by the Primary Glass Manufacturer's Council, and analysis of envelope conservation measures for a building energy standard for Hong Kong. Prior to joining Eley Associates in 1990, Mr. Kolderup worked as an electrical engineer with the Center for Industrial Research in Oslo, Norway.

- Master of Science, Industrial Engineering, Stanford University, 1990
- Master of Science and Bachelor of Science, Electrical Engineering, Stanford University, 1986
- Licensed Electrical Engineer, State of California
- Association of Energy Engineers, member
- American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), member
- U.S. Green Building Council, member

Tanmay Tathagat, Energy Engineer
Mr. Tathagat joined Eley Associates in 1997 as a specialist in building energy simulation and energy efficient building design. With Eley Associates, he has analyzed savings for several commercial retrofit and new construction projects including a high-rise office tower and a State of California office building. He has developed calibrated simulation models using VisualDOE and DOE2.1E. Prior to joining Eley Associates, Mr. Tathagat performed simulations and energy analysis as part of research at Arizona State University's Building Energy Simulation Lab. Also

while at ASU, he worked as an intern and research assistant at the APS Solar Test and Research Center, performing installation, maintenance and testing of photovoltaic systems. In India, Mr. Tathagat was a research associate for two years with the Passive and Low Energy Research Center in the School of Planning and Architecture in New Delhi. Work included design and thermal analysis of passive and low energy buildings.

- Master of Science, Building Design, with emphasis in Building Energy Simulation, Arizona State University, 1996
- Bachelor of Architecture, School of Planning and Architecture, New Delhi, India, 1992

Tianzhen Hong, Energy Engineer/Programmer

Dr. Hong joined Eley Associates in 1999 and has quickly become an important member of the energy software development team. Prior to joining Eley Associates, Dr. Hong was the Senior R&D Engineer with SuperSymmetry Services in Singapore. While he was a PhD candidate, Mr. Hong worked as an attachment with Building Research Establishment in the United Kingdom. He also was a postdoctoral research fellow at the National University of Singapore and a lecturer at Tsinghua University, China. Dr. Hong has participated in dozens of building science research and development projects. He has wide interest in building science. His experience covers building HVACR modeling, simulation, optimization, and diagnosis. He has co-authored more than 30 technical papers and reports since 1988.

- Ph.D, Master of Science, Thermal Engineering, Tsinghua University, China, 1994
- Bachelor of Engineering of HVACR, Bachelor of Science, Applied Mathematics, Tsinghua University, China, 1991
- Association of Energy Engineers, Senior Member
- American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), Member

Arman Shehabi, Energy Engineer

Mr. Shehabi joined Eley Associates in 2000 as an energy engineer to assist in the identification and evaluation of building efficiency measures. Project experience includes energy simulations and regression analysis to support updates to the State of California's energy efficiency standards. Prior to joining Eley Associates, Mr. Shehabi was a chemistry instructor and national consultant with The Princeton Review. He designed and conducted classes, which earned him The Princeton Review award for teaching excellence. At Stanford University, his training included work in energy efficient building design and renewable energy sources.

- Master of Science, Environmental Engineering, Stanford University, 2000
- Bachelor of Arts, Environmental Chemistry, University of California, San Diego, 1997

Larry Ayers, LC, Senior Lighting Engineer

Mr. Ayers joined Eley Associates in 2001 to assist with lighting and related projects. His background with photometric testing laboratories and with lighting energy efforts in California and other states helps with key Eley Associates work. He has more than 25 years experience in

lighting, and is Lighting Certified by NCQLP. Mr. Ayers joined the Illuminating Engineering Society of North America in 1975, and is active in their local, regional and international levels. Before joining Eley Associates, Mr. Ayers operated the Lighting Information Office for the Electric Power Research Institute as an Engineering Consultant for Bevilacqua Knight, Inc. He was Photometric Division Manager for ETL Testing Laboratories, Laboratory Facilities Manager for Gardco Lighting and Vice President, Testing, for Environmental Research Laboratories. His background includes testing all types of lighting products and optical design for lighting systems.

- Bachelor of Arts, Physics, University of California, Santa Barbara, 1971
- Lighting courses, University of Colorado, Boulder, 1975
- Illuminating Engineering Society, Member
- IES Testing Procedures Committee
- IES International Illumination Design Awards Committee
- IES South Pacific Coast Region Program Chair
- IES Golden Gate Section Secretary
- Lighting Certified by NCQLP

8.3.5 Portland Energy Conservation, Inc.

Tudi Haasl, Associate Director for Commercial Services

Tudi Haasl's background ranges from institutional and commercial building operations and facility management in the private sector to installing, commissioning and auditing energy conservation measures for utilities. Her experience in the field of O & M and commissioning for commercial buildings spans 16 years. Ms. Haasl wrote a comprehensive guide on commissioning existing buildings for Oak Ridge National Labs which was published in 1998. She also managed the State of Tennessee demonstration project and program design initiative to perform existing building commissioning in state facilities. Ms. Haasl was technical lead on the US DOE/EPA cooperative agreement investigating operations and maintenance practices in commercial buildings where she lead an O & M Tune-up study on five buildings throughout the U.S.

Ms. Haasl was responsible for all site work conducted for the PECI/Southern California Edison commissioning pilot investigation which included the design and implementation of the O & M assessments, diagnostics, commissioning, and post-commissioning data analysis. She has designed and delivered numerous workshops and training programs for utility staff, commissioning providers, and operation and maintenance staff. Ms. Haasl held principal responsibility for site testing and writing the revised Bonneville *Building Commissioning Guidelines*. She works with utilities, and federal, state and local governments to develop commissioning programs that integrate with existing or planned program concepts.

- Bachelor of Education, University of Wisconsin, Whitewater, Wisconsin
- Associate Degree, Structural Drafting, North Seattle Community College, Washington
- Professional training in lighting (IES Lighting Certificate), HVAC-System Design, industrial energy audits and energy-efficient refrigeration systems.

Carolyn Dasher, Senior Project Manager
Carolyn Dasher has been involved in the design, research, and implementation of energy-efficiency projects at PECI since 1993, especially those projects related to building commissioning and operation and management. She currently manages PECI's work to assess methods for Automated and Continuous Commissioning of Building Systems for the Air-conditioning & Refrigeration Technology Institute. She also manages the development of commissioning-related resources and training presentations for Pacific Gas & Electric's Savings by Design program. In addition, she oversees the commissioning consultant work for the Oregon Office of Energy's portion of the Commissioning Northwest Public Buildings project (funded by the Northwest Energy Efficiency Alliance).

Ms. Dasher has participated in planning and organization of the National Conference on Building Commissioning since 1994. She currently manages and serves as chair of the conference. Other examples of her work include designing and implementing a nationwide survey of energy efficiency practices in public schools for the US Department of Energy; implementing a nationwide survey of commissioning service providers; conducting literature reviews for the US Environmental Protection Agency and the US Department of Energy; and developing marketing materials and concepts for a utility's small commercial customers.

- Bachelor of Arts, Sociology and Foreign Affairs, Baylor University, Waco, Texas
- Master of International Affairs, George Washington University, Washington, D.C.

Amanda Potter, Project Manager
Amanda Potter is a Project Manager for new and existing building commissioning projects at PECI. She is currently managing three projects designed to reduce energy use in California. One is a feasibility analysis project for incorporating performance verification into the California Energy Code (as a subcontractor to the New Buildings Institute for the California Energy Commission). She is also working on three guides for Pacific Gas & Electric that help designers ensure energy efficient designs are implemented correctly in the field -- by ensuring they are clearly detailed, specified and constructed. Ms. Potter also manages a retrocommissioning market transformation project for long-term care facilities (as a subcontractor to the Institute for Market Transformation for Pacific Gas & Electric).

Ms. Potter has also worked with Nike to analyze energy saving strategies for their shoe manufacturing factories and has developed new opportunities for PECI in hydrogen and building integrated photovoltaics. Ms. Potter joined PECI in 1999 as Program Coordinator of the Energy Star® Resource-Efficient Clothes Washer program. In that role, she worked with utilities, manufacturers, field representatives, and retail stores to promote the sales of Energy Star®-qualified clothes washers. Previously, Ms. Potter researched and wrote about solar and wind systems at Home Power magazine and did energy audits for small businesses as an energy-efficiency consultant for PG&E. She's also taught high school physics and chemistry and worked as a technical marketing engineer for Chips & Technologies in Silicon Valley.

- Teaching Credential in Physics, Chemistry, Biology, Mathematics, Humboldt State University, Aracta, CA

- Diplome D'Etudes Approfondie in Electrical Engineering (equivalent to a US Master of Engineering degree), Ecole Centrale de Lyon, Ecully, France.
- Bachelor of Science degree in Electrical Engineering, Cornell University, Ithaca, NY

Eric Baxter, Project Coordinator
Eric Baxter coordinates commissioning related projects and activities at PECI. His current tasks include developing educational materials to promote building commissioning to commercial building owners and designers for Pacific Gas & Electric and assisting with the facilitation of the National Conference on Building Commissioning.
As an energy specialist for the Oregon Office of Energy, Eric previously developed and implemented a $40 million dollar/year sales and marketing plan for the state of Oregon's Business Energy Tax Credit. In addition, he researched and evaluated state construction projects completed under Oregon's Energy Efficient Design program and analyzed energy saving performance contracting opportunities for public facilities throughout the state.

- AAS degree in Energy Management, Lane Community College, Eugene, OR
- BA degree in Urban Studies, Occidental College

Diane Ferington, Project Coordinator/Development Assistant
Diane Ferington joined PECI in 1998. Ms. Ferington is the coordinator for the National Conference on Building Commissioning. Ms. Ferington assists in all aspects of conference planning, including recruiting sponsors and speakers. Diane led a New York State Energy Research and Development Authority market research project, which investigated efficiency opportunities in New York City multi-family coin-op facilities. This project involved interviewing market participants in New York City and writing a report containing a market assessment identifying the barriers and opportunities that exist for efficiency improvements. For the U.S. EPA series of O & M Best Practices Guides for facilities managers and operators, Diane provides desktop publishing assistance with the documents as well as research for developing a distribution plan for these documents. Diane is highly skilled in the development of advanced databases and has been involved in the development of two Access based software products developed by PECI. Diane also does PECI's Web site maintenance and system backups. In addition, Ms. Ferington assists the Commercial Director in new business development.

- Bachelor of Science, Business Administration-Marketing & International Business, Oregon State University, Corvallis, Oregon.

8.3.6 Eskinder Berhanu Associates

Eskinder Berhanu, P.E., Principal & Senior Engineer
Mr. Berhanu, the Principal of Eskinder Berhanu & Associates located in San Diego, California, leads the company in the development, implementation and evaluation of energy efficiency projects. He performs complex DOE-2 energy analysis and reporting and leads senior engineering staff for all projects, ensuring that the objectives are achieved on time and under budget.

Mr. Berhanu has extensive experience in building energy simulations and analysis using DOE-2 for commercial, residential, industrial and institutional sites in support of DSM program

evaluation projects for California utilities such as SMUD, PG&E, SCE, and SDG&E and other state agencies. His analysis expertise includes simple payback and lifecycle cost analysis for more than 100 school projects in California, in addition to Title 24 compliance checks for residential and nonresidential buildings.

Recently, Mr. Berhanu was a subcontractor to Architectural Energy Corporation to investigate the performance of packaged rooftop units in San Diego and Los Angeles. This work was part of Element 4: Small Commercial HVAC Systems research being conducted with PIER 3 funding from the California Energy Commission.

- Post-Master's work, Mechanical Engineering at the University of California at Irvine
- M.S., Mechanical Engineering from Howard University, Washington DC
- B.S., Mechanical Engineering, Addis Ababa University

9. Timeline For Program Implementation

9.1 Implementation Timeline

The California Building Energy Initiative program will be offered to eligible participants beginning April 1, 2002 through December 31, 2003. Due to the nature of the program's projects, participants will be required to complete their energy efficiency projects by March 31, 2004.

Appendices

Appendix A: Cost Effectiveness Workpapers

Appendix B: Program Cost Proposal

Appendix A: Cost Effectiveness Workpapers

Cost-Effectiveness Requirements

In Decision (D.) 01-11-066, the Commission approved the Energy Efficiency Policy Manual (Policy Manual).[1] The Policy Manual includes requirements for the development of prospective cost-effectiveness values for programs funded by electric and gas public goods charge (PGC) funds. Specifically, Chapter 4 of the Policy Manual requests that each program proposal present the results of the TRC and Participant Test, pursuant to the requirements of the Standard Practice Manual[2], on a prospective basis.[3]

D.01-11-066 and the Policy Manual require that each party utilize the cost-effectiveness inputs specified in the Policy Manual for calculating cost-effectiveness for the 2002 programs. These inputs will be reviewed and updated as necessary. The values included in the Policy Manual include net-to-gross ratios, measure lives, avoided costs, discount rate, and recommendations for incremental measure cost and energy savings estimates.

The values discussed in the Policy Manual have been utilized in the development of the cost-effectiveness calculations for 2002. In certain cases, updates to these values have been provided to the public and the most recent input value was utilized and provided to the Energy Division for updates to the Policy Manual.

Appendix A to the Policy Manual, the Program Technical Proposal Format, requires that this Section 4 of the Program Technical Proposal include the documentation of all data sources and an electronic spreadsheet file containing projected electricity (kWh), peak demand (kW), and gas (therms) savings for each program. These workpapers are provided at the end of this Program Technical Proposal. The workpapers provide the measure-level cost-effectiveness calculations, utilizing the latest input values, as described above. The cost-effectiveness showing for each program was coordinated among the utilities. To the extent practicable, the tables presented in this section utilize consistent inputs. There was a particular effort made to ensure that the inputs for the statewide programs are consistent.

Cost-Effectiveness Inputs

Units (Number and Definition)
Estimates of the unit count as displayed in the workpapers are based upon the best available information regarding the impact of each of the programs for 2002. Many of the estimates were based upon the knowledge of the success of the 2000 and 2001 programs and other years in which similar programs were offered. The definition of the unit is tailored to the specifications of the individual measure(s) offered in the program. The unit count includes units installed in 2002 and those units associated with commitments from 2002 programs.

[1] D.01-11-066, Ordering Paragraph 1.
[2] California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects, October 2001.
[3] D.01-11-066, Attachment 1.

Energy, Capacity, and Therm Savings (per unit and Total)
The projected annual program energy, capacity, and therm reductions are derived from *ex ante* estimates of savings. Annual program energy, capacity, and therm reduction estimates for the programs are the result of a summation of measure-level savings from the measures installed as a result of the 2002 programs. The measure-level savings information used to calculate the 2002 program results are based upon the results of the CBEI Pilot Program described earlier in this document.

Although it is the intention of each of the energy efficiency programs to encourage the efficient utilization of electricity and/or natural gas, the calculations performed for the 2002 program cost-effectiveness utilize energy, capacity, and therm savings estimates for measures and programs for which there is a lower degree of speculation. The lack of energy savings, capacity savings, resource benefits, or a TRC ratio for any particular program (e.g., information programs) should not imply that a measure or program does not promote energy efficiency nor should it imply that there is not an impact to the customer's use of electricity or a corresponding impact to the electricity system.

The energy and capacity savings for the statewide programs were coordinated among the Large Investor-Owned Utilities (IOUs). For climate-zone specific measures, there may be differences in the savings attributed to a particular measure. In addition, TRC and Participant Test ratios for statewide programs will differ among utilities based upon the amount of units forecast and the administrative costs associated with each utility.

The gross amounts of the annual energy, capacity, and therm savings are reduced by appropriate net-to-gross ratios for the particular measure or end-use and extended through their useful lives by the appropriate effective useful life estimates (see more information in Net-to-Gross and Effective Useful Life sections below).

Net-to-Gross Ratio
Gross energy savings are considered to be the savings in energy and demand seen by the participant at the meter. Net savings are assumed to be the savings that are attributable to the program. That is, net savings are gross savings minus those changes in energy use and demand that would have happened even in the absence of the program (free riders). The net-to-gross ratio is a factor that is applied to gross program load impacts to convert them into net program load impacts. This factor is also used to convert gross measure costs into net measure costs.

The Net-to-Gross ratios utilized in the 2002 program cost-effectiveness calculations are set at the levels recommended in the Policy Manual.

Effective Useful Life
The Effective Useful Life is the length of time (years) for which the load impacts of an energy efficiency measure are expected to last.

The useful life estimates are also based upon the amounts recommended in the Policy Manual. In certain cases, updates to these values have been provided and the most recent input value was utilized and provided to the Energy Division.

Incremental Measure Cost (per unit and Total)
These costs generally represent the incremental costs of energy efficiency measures over the standard replacement measures. The gross amounts of these costs are reduced by appropriate net-to-gross ratios for the particular measure or end-use. The incremental measure costs are typically derived from the latest measure cost study. In certain cases a measure that is projected to be offered in PY 2002 may not appear in the latest measure cost study. Pursuant to the Policy Manual, where a measure cost is not from the latest measure costs study, other values may be used and documented in the workpapers.

Program Incentive Cost (per unit and Total) and Administrative Costs
Incentive costs are estimates of the incentives to be paid to customers during 2002 as well as incentives associated with commitments from the 2002 programs. The incentive cost forecasts are based upon the per unit incentive costs paid to the customer multiplied by the total number of units.

Program administrative costs include all administrative costs as reported in the program budget.

Avoided Electric and Gas Supply Costs
Chapter 4 of the Policy Manual requests that each program proposal presents the cost-effectiveness results of the TRC and Participant Test, pursuant to the requirements of the Standard Practice Manual, on a prospective basis. The avoided costs utilized in the Total Resource Cost calculations represent the avoided costs as recommended in the Policy Manual.

The avoided costs utilized in the cost-effectiveness analysis of the programs herein are only applicable to the appropriate development of energy efficiency programs for 2002. The factors utilized in the development of these avoided costs were adopted specifically to reflect an appropriate and approximate value for the reduced energy and capacity savings due to energy efficiency programs. As such, these costs should not be used in any other context and should also be reviewed for future use in energy efficiency program planning and evaluation.

Avoided Electric and Gas Customer Costs
Chapter 4 of the Policy Manual requests that each program proposal presents the cost-effectiveness results of the TRC and Participant Test, pursuant to the requirements of the Standard Practice Manual, on a prospective basis. A long-term forecast of electric and natural gas rates is not provided in the Policy Manual to calculate the Participant Test. To the extent practicable, the utilities propose to utilize the total Electric and Gas Avoided Costs streams as stated in Table 4.3 of the Policy Manual and described above as the long term forecast of electric and gas rates for calculating the Participant Test. This proposal has been recommended to the Energy Division staff.

Appendix B: Program Cost Proposal

Table B.1. Budget Summary - PG&E			
Item	**First Year Cost**	**Second Year Cost**	**Total Cost**
Admimistrative Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$80,750	$112,323	$193,073
Travel Costs	$9,500	$13,215	$22,715
Other Direct Costs	$4,750	$6,607	$11,357
Subcontractors			
Fully Loaded Labor	$0	$0	$0
Travel Costs	$0	$0	$0
Other Direct Costs	$0	$0	$0
Administrative Costs Subtotal	**$95,000**	**$132,145**	**$227,145**
Marketing/Advertising/Outreach Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$31,725	$44,130	$75,855
Travel Costs	$8,037	$11,180	$19,217
Other Direct Costs	$2,538	$3,530	$6,068
Subcontractors			
Fully Loaded Labor	$33,390	$46,445	$79,835
Travel Costs	$6,678	$9,289	$15,967
Other Direct Costs	$7,632	$10,616	$18,248
M/A/O Costs Subtotal	**$90,000**	**$125,190**	**$215,190**
Direct Implementation Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$365,324	$508,165	$873,489
Travel Costs	$71,720	$99,763	$171,483
Other Direct Costs	$11,206	$15,588	$26,794
Subcontractors			
Fully Loaded Labor	$335,576	$466,786	$802,362
Travel Costs	$22,005	$30,609	$52,614
Other Direct Costs	$9,169	$12,754	$21,923
Other Direct Costs			
Portable Data Loggers	$200,000	$260,000	$460,000
Permanent Monitoring Systems	$200,000	$260,000	$460,000
Financial Incentives	$200,000	$260,000	$460,000
Direct Impl. Cost Subtotal	**$1,415,000**	**$1,913,665**	**$3,328,665**
Evaluation, Measurement and Verification Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$61,200	$84,660	$145,860
Travel Costs	$9,000	$12,450	$21,450
Other Direct Costs	$10,800	$14,940	$25,740
Subcontractors			
Fully Loaded Labor	$68,400	$94,620	$163,020
Travel Costs	$11,700	$16,185	$27,885
Other Direct Costs	$18,900	$26,145	$45,045
E, M&V Subtotal	**$180,000**	**$249,000**	**$429,000**
	Other Costs		
Architectural Energy Corporation	$0	$0	$0
Subcontractors	$0	$0	$0
Other Costs Subtotal	**$0**	**$0**	$0
TOTAL PROGRAM BUDGET	$1,780,000	$2,420,000	$4,200,000
IOU Administrative Fee (5%)	$89,000	$121,000	$210,000
TOTAL BUDGET	**$1,869,000**	**$2,541,000**	**$4,410,000**

Table B.2. Budget Summary - SCE			
Item	**First Year Cost**	**Second Year Cost**	**Total Cost**
Admimistrative Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$64,600	$90,723	$155,323
Travel Costs	$7,600	$10,673	$18,273
Other Direct Costs	$3,800	$5,337	$9,137
Subcontractors			
Fully Loaded Labor	$0	$0	$0
Travel Costs	$0	$0	$0
Other Direct Costs	$0	$0	$0
Administrative Costs Subtotal	**$76,000**	**$106,733**	**$182,733**
Marketing/Advertising/Outreach Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$25,380	$35,643	$61,023
Travel Costs	$6,430	$9,030	$15,460
Other Direct Costs	$2,030	$2,850	$4,880
Subcontractors			
Fully Loaded Labor	$26,712	$37,514	$64,226
Travel Costs	$5,342	$7,503	$12,845
Other Direct Costs	$6,106	$8,575	$14,681
M/A/O Costs Subtotal	**$72,000**	**$101,115**	**$173,115**
Direct Implementation Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$292,259	$410,441	$702,700
Travel Costs	$57,376	$80,577	$137,953
Other Direct Costs	$8,965	$12,590	$21,555
Subcontractors			
Fully Loaded Labor	$268,461	$377,020	$645,481
Travel Costs	$17,604	$24,723	$42,327
Other Direct Costs	$7,335	$10,301	$17,636
Other Direct Costs			
Portable Data Loggers	$160,000	$210,000	$370,000
Permanent Monitoring Systems	$160,000	$210,000	$370,000
Financial Incentives	$160,000	$210,000	$370,000
Direct Impl. Cost Subtotal	**$1,132,000**	**$1,545,652**	**$2,677,652**
Evaluation, Measurement and Verification Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$49,300	$66,810	$116,110
Travel Costs	$7,250	$9,825	$17,075
Other Direct Costs	$8,700	$11,790	$20,490
Subcontractors			
Fully Loaded Labor	$55,100	$74,670	$129,770
Travel Costs	$9,425	$12,773	$22,198
Other Direct Costs	$15,225	$20,632	$35,857
E, M&V Subtotal	**$145,000**	**$196,500**	**$341,500**
	Other Costs		
Architectural Energy Corporation	$0	$0	$0
Subcontractors	$0	$0	$0
Other Costs Subtotal	**$0**	**$0**	**$0**
TOTAL PROGRAM BUDGET	$1,425,000	$1,950,000	$3,375,000
IOU Administrative Fee (5%)	$71,250	$97,500	$168,750
TOTAL BUDGET	**$1,496,250**	**$2,047,500**	**$3,543,750**

Table B.3. Budget Summary - SDG&E			
Item	**First Year Cost**	**Second Year Cost**	**Total Cost**
Admimistrative Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$26,244	$36,721	$62,965
Travel Costs	$3,087	$4,320	$7,407
Other Direct Costs	$1,544	$2,160	$3,704
Subcontractors			
Fully Loaded Labor	$0	$0	$0
Travel Costs	$0	$0	$0
Other Direct Costs	$0	$0	$0
Administrative Costs Subtotal	**$30,875**	**$43,201**	**$74,076**
Marketing/Advertising/Outreach Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$10,311	$14,427	$24,738
Travel Costs	$2,612	$3,655	$6,267
Other Direct Costs	$825	$1,154	$1,979
Subcontractors			
Fully Loaded Labor	$10,852	$15,184	$26,036
Travel Costs	$2,170	$3,037	$5,207
Other Direct Costs	$2,480	$3,471	$5,951
M/A/O Costs Subtotal	**$29,250**	**$40,928**	**$70,178**
Direct Implementation Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$118,730	$166,131	$284,861
Travel Costs	$23,309	$32,615	$55,924
Other Direct Costs	$3,642	$5,096	$8,738
Subcontractors			
Fully Loaded Labor	$109,062	$152,603	$261,665
Travel Costs	$7,152	$10,007	$17,159
Other Direct Costs	$2,980	$4,169	$7,149
Other Direct Costs			
Portable Data Loggers	$65,000	$85,000	$150,000
Permanent Monitoring Systems	$65,000	$85,000	$150,000
Financial Incentives	$65,000	$85,000	$150,000
Direct Impl. Cost Subtotal	**$459,875**	**$625,621**	**$1,085,496**
Evaluation, Measurement and Verification Costs			
Architectural Energy Corporation			
Fully Loaded Labor	$18,700	$27,285	$45,985
Travel Costs	$2,750	$4,013	$6,763
Other Direct Costs	$3,300	$4,815	$8,115
Subcontractors			
Fully Loaded Labor	$20,900	$30,495	$51,395
Travel Costs	$3,575	$5,216	$8,791
Other Direct Costs	$5,775	$8,426	$14,201
E, M&V Subtotal	**$55,000**	**$80,250**	**$135,250**
	Other Costs		
Architectural Energy Corporation	$0	$0	$0
Subcontractors	$0	$0	$0
Other Costs Subtotal	**$0**	**$0**	**$0**
The costs for Architectural Energy Corporation and its project team members to conduct the			
TOTAL PROGRAM BUDGET	$575,000	$790,000	$1,365,000
IOU Administrative Fee (5%)	$28,750	$39,500	$68,250
TOTAL BUDGET	**$603,750**	**$829,500**	**$1,433,250**

California Building Energy Initiative are shown in Tables B.1 through B.3. Table B.1 is the Budget Summary for PG&E service terriorory, Table B.2 is the Budget Summary for SCE service territory, and Table B.3 is the budget summary for SDG&E service territory.

The total cost of fully loaded labor, the number of labor hours, and the average cost of labor for each service territory in each program year are shown in Table B.4.

Table B.4 Labor Summary

	PG&E 2002	PG&E 2003	SCE 2002	SCE 2003	SDG&E 2002	SDG&E 2003
Fully Loaded Labor Cost	$976,365	$1,357,130	$781,812	$1,092,820	$314,800	$442,846
Labor Hours	9,565	12,425	7,660	10,000	3,085	4,055
Ave. Fully Loaded Hourly Cost	$102	$109	$102	$109	$102	$109

Labor categories and hourly rates for Architectural Energy Corporation in each program year are shown in Table B.5. Labor categories and hourly rate ranges for subcontractors are shown in Table B.6. Ranges are shown for subcontractors because rates vary among the subcontractor organizations. Based upon our experience in dagnostic testing and the CBEI Pilot Program, the work in this program is best accomplisehd through a combination of a Senior Engineer responsible for the audit, diagnstic testing and engineering analysis, working with and being supported by a Staff or Associate Level engineer assisting with monitoring and analysis. Consequently, the hourly rate tends to be the average between these two labor acategories, as in AEC's case this is $ $91.50 per hour in 2002 and $95.25 per hour in 2003. Labor costs for subcontractors from California tend to be higher. Hence, the average labor costs of $102 per hour in 2002 and $109 per hour in 2003 are reasonable for this type of program.

Table B.5 Architectural Energy Corporation Fully Loaded Labor Rates

JOB CLASSIFICATION	FEE RATE YEAR 1 (2002)	FEE RATE YEAR 2 (2003)
Principal	$147.00	$155.00
Senior Engineer II	$121.00	$127.00
Senior Engineer I	$95.00	$99.00
Staff Engineer II	$79.00	$83.00
Staff Engineer I	$68.00	$72.00
Associate Engineer	$63.00	$66.00
Hardware Manager	$75.00	$79.00

Table B.6 Subcontractor Fully Loaded Labor Rates

JOB CLASSIFICATION	FEE RATE YEAR 1 (2002)	FEE RATE YEAR 2 (2003)
Principal	$150.00 to $225.00	$157.50 to $235.00
Registered Engineer	$93.00 to $129.00	$98 to 135.00
Senior Analyst	$88.00 to $93.00	$92.00 to 98.00
Staff Engineer	$62.00 to $77.00	$65.00 to $81.00

Program Cost Definitions

Administrative Costs

The Administrative Costs are all the costs associated with managing the CBEI program activities and preparing reports to the Commission and contracting utility. Only Architectural Energy Corporation will incur these costs. The costs are broken down among the following elements:

Fully Loaded Labor: The fully loaded labor includes all the direct labor costs (wages), overhead costs, and profit. Overhead costs include all indirect operating expenses, fringe benefits, and G&A expenses, including indirect salaries. The State of California has audited AEC's financial records as part of our participation in the CEC PIER research. The State Controller's Office has recommended that we use a single overhead rate that includes all G&A expenses and fringe benefits.

Travel Costs: The travel costs include all modes of travel, such as air fare and rental car charges, lodging, meal expenses, parking expenses, and miscellaneous per diem expenses. They also include expenses for privately-owned vehicles, such as mileage and parking. AEC requires employees to provide receipts for all expenses greater than $10.00.

Other Direct Costs: Other direct costs include long distance telephone charges, postage and delivery, charges for outside copying and reproduction services, and miscellaneous charges for items that are directly related to projects.

Marketing/Advertising/Outreach Costs

The Marketing, Advertising, and Outreach Costs include the same cost elements described for the Administrative Costs. Fully Loaded Labor, Travel Costs, and Indirect Costs are as defined above. Market research, promotional activities, and participant recruiting are conducted under this classification. The Indirect Costs also includes expenses for the creation and distribution of promotional items distributed at various events to promote and provide information about CBEI program. Electronic or printed media advertising, booklets and brochures are also included. Costs are shown for AEC and subcontractors.

Direct Implementation Costs

The Direct Implementation Costs are the costs to implement the CBEI program activities with the participants. They include Fully Loaded Labor, Travel Costs, and Other Direct Costs. All of these are described above. Additional direct costs are for Portable Data

Loggers, Permanent Monitoring Systems, and Financial Incentives. Costs are shown for AEC and subcontractors.

Portable Data Loggers: The Portable Data Loggers will be given to the participants after they implement the improvements. The purpose for giving them these tools is to investigate and improve the performance of other buildings under their control, not participating in the CBEI.

Permanent Monitoring Systems: The Permanent Monitoring Systems will be installed after the improvements are complete. These allow near real-time access to performance data to improve the persistence of savings and to perform M&V activities.

Financial Incentives: The Financial Incentives are cash incentives paid to the participants after completion of the improvements. The amount of the incentive is tied to the amount of energy saved and the cost of implementation. These costs are shown on the cost effectiveness tables shown in the program proposal.

Evaluation, Measurement and Verification Costs

The E, M&V costs are shown separately. They include Fully Loaded Labor, Travel Costs, and Other Direct Costs. All of these are described above. Costs are shown for AEC and subcontractors.

Other Costs

No costs are shown in this category. Profit is included in the fully loaded labor rates. We do not anticipate any financing costs.